Engineering News-Record

Devoted to Civil Engineering and Contracting
McGraw-Hill Company, Inc.

June 10, 1920

Engineering Library
GENERAL LIBRARY
JUN 12 1920
UNIV. OF MICH.

In This Issue:

The Organizing Conference

Report of the Meeting Held in Washington, D.C. Last Week to Consider Creation of a Federation of Engineering Societies

Technical Articles:

Design of Dams and Auxiliary Structures
Miami Conservancy District

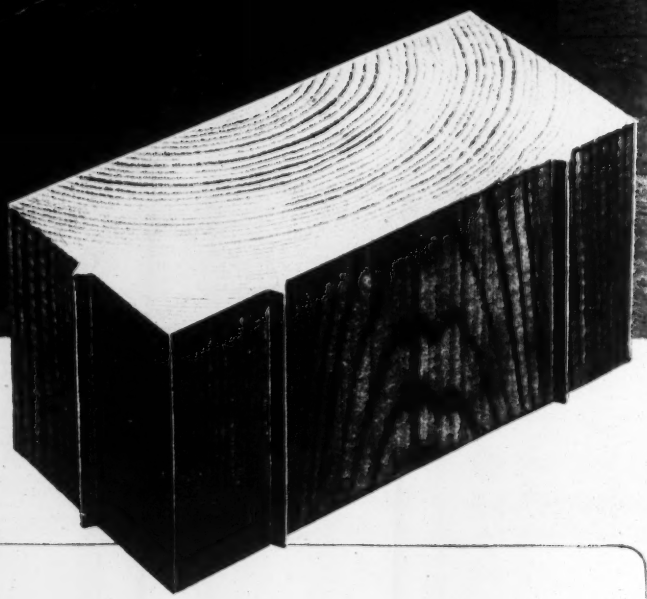
Factors Affecting the Use of Water in Irrigation
By E. A. Moritz
U.S. Reclamation Service

Marine Railway for 5000-Ton Ships
By C. O. Crisman

Cover Illustration:
Upper End of Jump Pool, Lockington Dam, Miami Flood Protection Works

KREOLITE LUG WOOD BLOCKS

"The Paving that's Saving"



No Wear After Years of Service

The Kreolite Lug Wood Block pavement on Jackson Ave., Toledo, Ohio, was laid in the early summer of 1912. The above picture was taken in April, 1920.

There is a noticeable freedom from cobbling, or wearing at the joints. This is especially interesting in view of the fact that the street is very heavily traveled and is on about a four per cent grade.

The lugs on the blocks provide ample room for expansion, preventing any buckling or bleeding and also offer a foothold for horses. Team owners report that their horses are able to get a secure foothold on this pavement in spite of the grade.

Evidence of this kind tends to prove our claim that the lugs "make a good block better." There are now over a million square yards in service in all parts of the United States.

Write the Toledo Office for further information on Kreolite Lug Wood Blocks, "The Paving That's Saving."

The Jennison-Wright Company, 79 Kreolite Bldg., Toledo, Ohio

Branches: New York, Chicago, Philadelphia, St. Louis, Pittsburgh, Cleveland, Detroit, Toronto and other principal cities
British Distributors—Anglo-American Agency, Royal Liver Bldg., Liverpool, Eng.

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—James H. McGraw, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. Mehren, Editor

Volume 84 — NEW YORK, THURSDAY, JUNE 10, 1920 — Number 24

Where Will City Wages Stop?

WITH unskilled municipal laborers at Albany, N. Y., and elsewhere asking for wage advances to $5 a day, the question naturally arises, where will city wages stop?

National Budget Must Come

FAILURE of the National budget bill by a last-minute filibuster in the Senate is a cause for deep regret. The United States has long stood alone among the nations of the world in having no budget system. State after state of the Union has recently enacted budget measures and our most progressive cities preceded the states in this particular. The sentiment of the country is now so strong for a national budget that it cannot be long postponed.

Hope for Better Government

PROMISE of better government for Atlanta is offered by the charter amendment campaign being waged under the leadership of its president, Eugene R. Black. A city manager is proposed and also a single- instead of two-chambered city council. Atlanta is one of the few American cities that still clings to the cumbersome bi-cameral city council, with its divided responsibility and delays. A single small legislative body with legislative powers only, and a chief executive officer, chosen for competence, and well paid, is the plan for a city that wishes to show twentieth century progress and efficiency.

Notes from Foreign Fields

ON PAGE 1169 of this issue appears the first of a series of impressions which E. J. Mehren, editor of *Engineering News-Record*, is writing during an extended European trip. No attempt will be made to introduce technical details into these letters. They are designed merely to picture things seen abroad through the eyes of an engineer-observer. This week's impressions concern London traffic and Westminster Abbey's tribute to famous engineers and scientists. Later letters will deal with such subjects as the Institution of Civil Engineers, random highway observations, and construction methods in England. During Mr. Mehren's progress through France and Germany notes on his experiences and general observations in those countries are expected.

Another Year Lost

BY HIS action in failing to approve the water-power bill, the President has postponed hydro-electric development at least one and possibly two years. The present Congress, which only just managed to agree on a bill, will hardly attempt to meet the President's mind again when it assembles in December. Unless there is an extra session the next Congress does not convene until December, 1921, at which time both legislative and executive personnel will be changed and the work of building up a water-power bill will have to start anew. As indicated in our news columns there is confusion in Washington as to why the President allowed the bill to lapse, but whatever the reasons, with coal and labor at their present price this is a poor time to hold up economical power for another two years.

The Largest City

DISAPPOINTMENT because New York City did not reach the six million mark in the 1920 census may well be momentary when all the data are considered. In fact, disappointment may properly give place to pride and congratulation. The gain for the decade is over 854,000, which alone would place New York fourth on the list of American cities, with possible apologies to Detroit when its count is announced. New York's total count of 5,621,151 makes it twice the size of any other American city and probably the largest in the world, London being the only possible near approach to a rival. Factors in the failure of New York to reach the six million mark are the practical stoppage of immigration during the war, heavy emigration immediately thereafter, housing shortage and other causes for the flow of population to the suburbs. These factors hit Manhattan borough hardest of all, and go far toward explaining its decline of 47,439 or 2 per cent in population. Presumably the other boroughs of Greater New York, as well as the suburbs, were gainers through these factors, especially by the conversion of dwelling sites into places of business. The heart of any metropolitan center is bound to lose population, first in percentage growth, then actually, as the decades pass. The real test of growth becomes more and more that of the whole metropolitan district. When the figures for the entire metropolitan district of New York are available it seems probable that they will show an excess over the London metropolitan district—but for the London figures we must await the British census of 1921. Meanwhile New York City may claim to be the largest city as well as the center of the largest metropolitan district in the world.

Rating Irrigation Districts

IRRIGATION engineers not familiar with the work of the engineer-appraisers in the service of the Federal Farm Loan Banks will find on p. 1100, of our issue of June 3, a classification of projects according to the adequacy of water supplies. The classification is the result of the observation of the engineers for the past three years. It must be borne in mind that the rating is made with special reference to the particular conditions under which these banks make loans. Primarily the land must

stand alone for the loans are all on such a long time basis, 34½ to 40 years, that personal credit, on which short time loans are ordinarily made, does not enter into consideration. Because intrinsic values only are considered, the classification of the appraisers must, therefore, be quite definite and stringent. On new projects it is conceivable that a higher rating might be obtained in some cases without undue additional expendtures, thereby raising the loan value of every owner in the district. Since on the ease, rapidity and succes of colonization depends the success of the project from the financial standpoint of the investor and the higher the rating the greater the loan value, irrigation engineers may well keep this classification in mind.

Speaking for the Profession

ENCOURAGEMENT and inspiration flow from the manfully expressed resolution of the Board of Direction of the American Society of Civil Engineers on the question of bridge design by architects. The statement of the board, quoted in full on p. 1175, is equally notable for what it says and for the way in which it is said. Both substance and manner of expression make obvious a conviction of a mission and a determination to uphold that mission: the representation of the civil engineering profession as a unified technical group.

There is no temporizing in the statement of the board, no evasion of a crucial question by disposing of it as administrative detail. When we deplored the findings of a committee of Engineering Council two weeks ago, because they failed as to underlying principle, we had in mind just such a statement of clean-cut conviction as that now given us. That Engineering Council went outside of its mandate in taking up the question—as is stated very distinctly in the resolution of the Board of Direction—may serve to explain the halting and evasive results reached by the council's committee. Where proper warrant of purpose is lacking, convictions are likely to be absent, or at least the courage to set forth these convictions in unmistakable terms. Conversely, the resolution of the board, in its manfully direct wording, is a most evident expression of authority to speak for civil engineers as a professional group.

Solidarity of civil engineers is vital to the interests of the profession. But those who are to speak for the profession must themselves be civil engineers. The power cannot be delegated to agents foreign to the needs and the traditions of civil engineering. This is an elementary truth, but because it is easily overlooked, or at a critical moment forgotten, the forceful expression given to it in the resolution of the Board of Direction is of high inspirational value. The entire membership of the society, the whole body of American civil engineers, indeed, may read in the words of the board a new expression of its own unity as a body of professional co-workers.

Guided by such a spirit as speaks from the board's resolution, the profession cannot fail to progress. There have been many centrifugal tendencies in the engineering world during recent months; there has been a startling lack of centripetal forces. So long as a group of clear-seeing, courageous and active men guide the work of the American Society of Civil Engineers and make it the militant champion of the interests of its members, a sound nucleus of professional strength will always exist, and both the public interest and the interests of the profession will be served. Under such leadership, any functions and services that can more fittingly be left to other organizations may and should be delegated. But the civil engineering profession will uphold the principle that, as custodian of a great science and art, it must retain the control of vital professional interests in its own hands.

The Federation of Engineering Societies

IN LAYING the foundation last week for a national federation of engineering societies the Organizing Conference at Washington, D. C., took action which will add a new chapter to American engineering history. The two-day meeting of delegates representing more than sixty national, state, and local societies, reported in detail elsewhere in this issue, was unique in its purpose, in the widely representative character of its participants, and in the spirit of co-operation and service which animated every session, and which, at times, seemed to transform the delegates from mere technical men concerned chiefly with the details of engineering construction and design into apostles of a new order of professional solidarity.

For years past there has been an apparent desire for engineering unity, for some agency which would endow the profession with a voice articulate throughout the nation. The federation born at the Organizing Conference will fill this need, provided that the work begun at Washington by the endorsement of a constitution and by-laws is followed up by all organizations which were represented at the gathering by delegates. The conference has done its part by building up and setting into motion the machinery for the federation; the societies must now discharge their obligations by an immediate canvass of their membership on the acceptance of the federation principle. Already the American Society of Mechanical Engineers—the only national organization which sent to the conference delegates empowered to act for it—has pledged its membership in the new federation. It appears, also, that the American Institute of Electrical Engineers will follow suit. Action by the other national and local societies should not be delayed.

Never before have engineering organizations throughout the country enjoyed the opportunity that is now presented to them of affiliating to secure united action. At one of its sessions the conference had the privilege of listening to an address by a business man whose views are entitled to great weight, Homer L. Ferguson, past-president of the United States Chamber of Commerce. In one sentence he epitomized the engineers' problem and its solution: "You won't have much of anything these days unless the voice of your business or profession is heard." This voice, to which Mr. Ferguson referred, must reach other ears than those of engineers. It has a real message to deliver—the message of service to the public through the use of technical knowledge and engineering experience. The voice of the engineer must be strong and must carry far. It will succeed in delivering its message to the nation only if it speaks for all, not one or more groups of engineers. The opportunity has arrived. It has been a long time coming. It should be grasped now, for it may not come again.

The conference was truly remarkable in its representative character, as indicated by the list of societies

and delegates on another page. Engineers have been criticised, and justly so, for their professional aloofness. During the past decade or so the profession has become highly specialized and where, in former times, we had only "engineers" we now have civil, mechanical, electrical, mining, industrial, automotive, and scores of other classifications. This specialization has tended to segregate engineers into groups working more or less independently. At the conference, however, engineers of all kinds met and worked together. While there are undeniable advantages in the form of organization by specialties for technical advancement, its drawbacks from the point of view of influencing public opinion and establishing engineers in the position which they should occupy in the minds of men are manifest. The federation of engineering societies, as did the conference which created it, offers to technical men, for the first time in their history, an opportunity of presenting a *united* front on matters of civic and economic import.

For just such an opportunity engineers have been groping for years past. No one who has attended society meetings, especially since the armistice was signed, can have failed to sense the desire for professional unity. Progress toward the achievement of this ambition has been delayed not by reason of an antipathy toward co-operative effort, but rather by uncertainty as to how best to achieve it. Temperamentally reticent in matters of self-advancement, engineers have remained divided into their little cliques while the lawyers, the doctors, the laborers, and the business men of the nation have banded together into powerful organizations, influential in molding public opinion and commanding the attention of national and state legislatures. The chief significance in the Organizing Conference, therefore, lies in the unmistakable proof which it affords that engineers *can* cast aside their old traditions and work together in a broad, co-operative movement.

So much, then, for the general scope of the conference and the opportunity which it offers. To readers of this journal the attitude of two organizations, the American Society of Civil Engineers and the American Association of Engineers, is of prime interest. When the civil engineers announced that they would send delegates to the conference—after the society's membership, in a letter ballot, had defeated the Joint Conference Committee's specific plan for an engineering federation—attention naturally centered upon the action of these delegates at the Washington meeting. While there is nothing of finality in their vote, inasmuch as they were not empowered to commit the society to any course of action, it is highly significant that the delegation of ten members, as a body, endorsed the principle of an engineering federation and its organization on lines of society, rather than individual, membership, and also approved the constitution and by-laws submitted for the new federation. Predictions that the civil engineer delegates might bolt, or at least assume an attitude of coldness toward the objects of the conference, certainly were not borne out by what happened at Washington. Willard Beahan's emphatic denial of the accusation that the society had gone on record as opposed to a federation of societies is, at least, a straw in the wind. The course is still clear for the American Society of Civil Engineers to join the federated movement. The membership will have an early opportunity to record its decision on the next letter ballot.

It was hardly to have been expected that the American Association of Engineers would have taken any action tending toward a transfer to a new organization of functions which it was organized primarily to carry out. W. J. H. Strong made the association's position clear in the statement which is referred to in the report of the conference elsewhere in this issue. It appears that A. A. E. will not become a member society of the federation, although the association has pledged its co-operation in the new movement. Of the sincerity of this pledge there can be no doubt. By their action in endorsing the Williams resolution endorsing the principles of the federation and its organization on society rather than individual membership lines and in many other ways the American Association of Engineers has gained great prestige as a constructive force in engineering affairs at a time when selfish interests might have seemed to justify an obstructionist policy at the Washington meeting. Nevertheless, no obstructionist tactics were employed, and, while differences of opinion were to have been expected, they were stated frankly, fearlessly and in a spirit of good will and co-operation. While the Federated American Engineering Societies and the American Association of Engineers may pursue separate ways, the prospect of any bitterness or strife between the two organizations in the conduct of their future work seems very remote.

The effect of the federation on the future of Engineering Council was not made the subject of any specific statement, but an interpretation of Philip N. Moore's remarks would indicate that Engineering Council will cease to function as soon as the new federation develops machinery which can handle the so-called welfare activities of the member societies. This seems logical.

A word as to the general conduct of the meeting is in order. The conference set a new mark in orderly parliamentary procedure, due to the combined influence of an efficient presiding officer and to the mental attitude of the delegates who realized that they were at Washington on a mission of tremendous importance to the profession they represented. Ample time and opportunity were available for full discussion of organizing details in spite of opinions to the contrary stated in advance of the meeting by interests not in sympathy with the movement, who believed that the program would be a "cut-and-dried" affair. There was a nicety of judgment shown in the apportionment of time between the business sessions and those at which speakers on general topics were scheduled, which produced a well-balanced, satisfying program.

It is to be remarked that the general trend of thought in the special addresses of business men and engineer-executives indicated that the engineer's chief deficiencies—which prevent him reaching heights hitherto unreached—are the lack of what was termed "the business instinct" and failure to take his part in public affairs. It seems to this journal, however, that the organization of the Federated American Engineering Societies is tangible evidence of a realization of these deficiencies and presents a well-conceived plan of action for correcting them. This new point of view will mean better things for city, state and country, and a brighter future for the engineer himself.

Organizing Conference Lays Foundation for "Federated American Engineering Societies"

Constitution for New National Body to Serve Public Welfare Through Professional Unity Adopted at Meeting of Delegates from 61 Organizations at Washington, D. C.

Dedicated to public service through the medium of technical knowledge and engineering experience, and to united action upon matters of common interest to the engineering and allied technical professions, an ational federation of engineering socieites took definite form last week when delegates of national, state and regional organizations throughout the country, at the closing session of the Organizing Conference held in Washington, D. C., June 3 and 4, unanimously approved a constitution and by-laws for the new body and gave to it the name of "The Federated American Engineering Societies." The federation was given an official status when L. P. Alford, representing the twelve delegates of the American Society of Mechanical Engineers — who had been sent to the conference with power to act for their organization announced that the society pledged its membership in the new federation. Speaking for the American Institute of Electrical Engineers, Calvert Townley assured the conference that he could predict with reasonable certainty that the American Institute of Electrical Engineers would be a participant in the new organization. Two other events in connection with the formation of the federation are significant: The first was the unanimous approval of the federation principle and the constitution and by-laws by the delegation of the American Society of Civil Engineers, headed by President Arthur P. Davis, and the frank admission by W. J. H. Strong, speaking for the 17 delegates of the American Association of Engineers, that while his organization would cooperate with the new federation in every possible way, it would probably not seek admission to membership. When the roll-call vote on the approval of the constitution and by-laws was begun the American Association of Engineers went on record as "present but not voting."

The conference was a notable one from many points of view. It marks the first definite step which engineers of the United States have ever taken to combine the country's separate organizations—national, state and local—into a single big affiliation of nation-wide scope. If the expectations for a representation of at least 100,000 engineers in the new body are realized it will carry a political influence never before approached in the history of American engineering. Another impressive feature about the meeting was its representative character. The creation of the Federated American Engineering Societies represents the wishes of no single group of engineers, for the delegates present hailed from California, New York, Florida, Minnesota, and all important centers between these localities. In addition to the four founder societies—the national organizations of civil, mechanical, mining, and electrical engineers—there were present delegates from state and regional organizations, as well as from engineer clubs of cities and local affiliations. The final count showed 61 organizations represented by 123 delegates. Representation at the meeting included, in addition to those national and local societies with which readers of *Engineering News-Record* are most familiar, organizations whose interests covered such widely divergent subjects as geology, ceramics, electro-chemistry, refrigeration, naval architecture, heating and ventilating, radio telegraphy, automotive industries, fire protection, military engineering, and other specialties.

The feature of really outstanding significance, however, was not the geographically representative character of the conference nor the diversified interests participating, but the spirit of co-operation and enthusiasm which was manifest at every session. The clear-cut impression carried away from the meeting can probably best be stated in these words: The engineering societies of the country, if truly represented by their delegates, have decided to speak with a united voice. They have determined to work for the public welfare and the advancement of the profession, not individually, but as a team.

Attitude of Am. Soc. C. E. and of A. A. E.

The observer familiar with the events which have led up to the conference looked to the meeting for answers to two questions. First: Will the American Association of Engineers participate in any federation formed? Second: What will be the attitude of the American Society of Civil Engineers in the light of the defeat by its membership of Question 3 on the recent letter ballot, which read, "Shall the Society, for the purposes set forth in Questions 1 and 2, actively co-operate in the creation of the comprehensive organization as outlined in the Joint Conference Committee report?"

As far as the A. A. E. was concerned, its attitude, as expressed by its delegates, boiled down about to this: Our organization is a going concern and is already accomplishing many of the objects sought by the new

federation of engineering societies. We are a large organization, having at present 18,125 members, and we believe that the results sought by the federation could best be achieved if engineers, as individuals, would join our organization. We feel, however, that the trend of opinion at the Organizing Conference is definitely toward the federated societies plan. In the way of any such federation we do not propose to place obstacles; we wish to co-operate with the new organization, but we do not feel that it would be consistent with the aims and objects of the American Association of Engineers to relinquish independent control of welfare work —the very purpose for which the association was formed—and join the federation.

The case of the American Society of Civil Engineers presents a different aspect. It will be recalled that the membership, on Questions 1 and 2 of the questionnaire ballot canvassed April 14, voted overwhelmingly in favor of the general principle of becoming an "active national force in economic, industrial, and civic affairs," and of co-operating with other engineering and allied technical associations in promoting the welfare of the engineering profession. In defeating Question 3 the society, as explained by Willard Beahan, one of its delegates, disapproved, not the general principle of a federation of engineering societies, but the specific plan of federation proposed in the Joint Conference Committee's report. The delegates of the American Society of Civil Engineers to the Organizing Conference were not empowered to act for the society. They will, however, bring back a report of the meeting and the decision on the question of joining the newly formed Federated American Engineering Societies will be submitted to letter ballot of the membership.

R. L. Humphrey Sounds Keynote

The keynote of the Organizing Conference was sounded at the opening session on the morning of June 3 in the auditorium of the Cosmos Club, when Richard L. Humphrey, chairman of the Joint Conference Committee of the four founder societies, which had issued the call for the meeting of delegates, presented a brief historical sketch of the movement toward a federation of engineering societies and stated that the time had now come for engineering organizations to decide whether to create a comprehensive organization or to pursue their ways separately. The conference, he explained, was made up of delegates named by national, state and regional organizations; to 110 of these societies invitations to participate in the conference had been sent. About 60 per cent of the organizations invited had sent delegates to the meeting. After these preliminary remarks the first business session was begun by the election of Calvert Townley, past president of the American Institute of Electrical Engineers, as chairman, and John C. Hoyt secretary.

Prominent at this first session was the delegation of 17 from the American Association of Engineers, grouped in three solid rows of seats at the front of the auditorium. The A. A. E. delegates had held a caucus in Washington the previous night, and it was apparent from the outset that they had agreed upon a well-defined plan of procedure. In fact, the early business of organizing the conference was largely done on the initiative of A. A. E. members.

Dr. F. H. Newell presented the first resolution, providing that the delegates at the meeting should have full power to make rules governing the procedure. Dr. Newell suggested also that certain set speeches on the program be eliminated in order to give the conference more time for a consideration of the matter of organizing the federation.

Williams Offers Basic Resolution

After it had been decided to limit all addresses from the floor to 5 min., Major Gardner S. Williams, representing the Grand Rapids (Mich.) Engineering Society, focused the attention of the delegates upon the fundamental objects of the meeting by offering the following resolution:

"Resolved, that it is the sense of this convention that an organization be created to further the public welfare wherever technical knowledge and engineering experience are involved, and to consider and act upon matters of common concern to the engineering and allied technical professions.

"Resolved, that it is the sense of this convention that the proposed organization should be an organization of societies or affiliations and not of individuals."

In this resolution the crux of the conference was contained, for it embodied two essentials upon which opinion was expected to differ: First, acceptance of the principle of an engineering federation; and, second, organization on the basis of *society*, rather than *individual*, membership. The first half of the resolution, obviously, would require a statement as to policy from the delegation of the American Society of Civil Engineers, while the latter half of the resolution was clearly aimed at the A. A. E. Action on this resolution would mean a square facing of the issues involved. Dr. Newell suggested a procedure, prior to a vote on the measure, by which every delegation present should express in 3-min. addresses its views on the Williams resolution. Objection to this scheme developed and the proposal was defeated.

"The vital question to be decided," said Dr. Newell "is whether the new organization is to be of societies or of individuals." The speaker then presented a brief history of what the American Association of Engineers had done since its organization in 1915 and invited members of other engineering societies to join with the 18,125 men now enrolled in A. A. E. Dr. Newell pointed out that if Major Williams' motion prevailed there would be two large societies, one of delegates and one of individuals, attempting to do the same kind of work. The A. A. E. movement, Dr. Newell contended, is now too great to be abandoned.

Opinion Favors Federation

A spirited discussion followed. Except among the A. A. E. delegates, opinion seemed decidedly in favor of the federation of societies. The general trend of thought is indicated by the remarks of C. E. Grunsky, representing the San Francisco Joint Council of Engineering Societies, who said: "A new society is needed to represent *organized engineering*." It was pointed out that the proposed federation would represent at least 100,000 engineers. The point of view of the small local engineering society was expressed by Major William J. Shea, representing the Brooklyn Engineers Club, who held that while the local society is doing excellent work, it needs some agency whereby its efforts can be

Engineering Societies and Delegates at Organizing Conference, Washington, D. C., June 3-4, 1920

American Association of Engineers,
L. K. SHERMAN, chairman, Washington, D. C.
R. C. BAILEY, Washington, D. C.
MORRIS BIEN, Washington, D. C.
W. A. H. DOYING, Washington, D. C.
GEORGE W. FULLER, New York City
H. O. GARMAN, Indianapolis, Ind.
A. N. JOHNSON, Chicago, Ill.
LEONARD B. SMITH, New York City
F. H. NEWELL, Urbana, Ill.
E. T. PERKINS, Chicago, Ill.
WM. J. H. STRONG, Chicago, Ill.
R. H. JACOBS, New York City
W. P. TUNSTALL, Norfolk, Va.
K. P. ARMSTRONG, Washington, D. C.
DEAN G. M. BUTLER, Tucson, Ariz.

American Association of Petroleum Geologists,
JAMES O. LEWIS, Washington, D. C.

American Ceramic Society,
E. W. WASHBURN, Urbana, Ill.

American Electric Railway Engineering Association,
J. H. HANNA, Washington, D. C.
C. S. KIMBALL, Washington, D. C.

American Electro-Chemical Society,
W. D. BANCROFT, Washington, D. C.
G. W. COGGESHALL, Washington, D. C.

American Institute of Electrical Engineers,
H. W. BUCK, chairman, New York City
A. W. BERRESFORD, Milwaukee, Wis.
JOHN H. FINNEY, Washington, D. C.
JAMES H. MCGRAW, New York City
L. F. MOREHOUSE, New York City
L. T. ROBINSON, Schenectady, N. Y.
SAMUEL SHELDON, Brooklyn, N. Y.
C. E. SKINNER, East Pittsburgh, Pa.
CALVERT TOWNLEY, New York City
R. H. DALGEISH, Washington, D. C.
C. F. LACOMBE, New York City
ROBERT P. PARROTT, Washington, D. C.

American Institute of Mining and Metallurgical Engineers,
PERCY E. BARBOUR, New York City
PHILIP N. MOORE, Washington, D. C.
ALLEN H. ROGERS, New York City
J. V. W. REYNDERS, New York City
G. AERSTEN, Nicetown, Pa.
CAPT. A. F. INCAS, Washington, D. C.
J. E. SPURR, New York City
H. G. POMEROY, Palo Alto, Cal.
THOS. T. READ, Washington, D. C.

American Railway Engineering Association,
EARL STIMSON, Baltimore, Md.

American Society of Agricultural Engineers,
M. A. R. KEELEY, Washington, D. C.

American Society of Civil Engineers,
ARTHUR P. DAVIS, chairman, Washington, D. C.
GEORGE G. ANDERSON, Los Angeles, Cal.
J. C. HOYT, Washington, D. C.
LEONARD METCALF, Boston, Mass.
E. E. WALL, St. Louis, Mo.
GARDNER S. WILLIAMS, Ann Arbor, Mich.
ROBERT A. CUMMINGS, Pittsburgh, Pa.
GEORGE R. PUTNAM, Washington, D. C.
WILLARD BEAHAN, Cleveland, Ohio

American Society of Naval Architects and Marine Engineers,
J. H. LINNARD, Washington, D. C.

American Society of Refrigerating Engineers,
W. H. ROSS, New York City

American Society for Testing Materials,
G. K. BURGESS, Washington, D. C.
G. S. WEBSTER, Philadelphia, Pa.
C. D. YOUNG, Philadelphia, Pa.

American Society of Heating and Ventilating Engineers,
C. L. RILEY, Plainfield, N. J.

American Waterworks Association,
JOHN M. GOODELL, Montclair, N. J.
EDWARD C. HARDY, Washington, D. C.

Associated Engineering Societies of St. Louis,
WILLIAM E. ROLFE, St. Louis, Mo.

Boston Society of Civil Engineers,
LEONARD METCALF, Boston, Mass.

Brooklyn Engineers Club,
WM. J. SHEA, Major, Washington, D. C.

Cleveland Engineering Society,
J. F. OBERLEIN, Cleveland, Ohio

Colorado Society of Engineers,
J. D. WARD, Philadelphia, Pa.

Duluth Engineers Club,
O. H. DICKERSON, Duluth, Minn.

Engineers Club of Baltimore,
W. W. VARNEY, Baltimore, Md.

Engineers' and Architects' Club of Louisville,
H. C. WILLIAMS, Louisville, Ky.

Engineers' Club of Philadelphia,
GUILLIAM AERTSEN, Nicetown, Pa.

Engineering Society of Eastern New York,
ARTHUR M. GREENE, JR., Troy, N. Y.

Engineering Society of Buffalo,
W. B. POWELL, Buffalo, N. Y.

Engineers' Society of Pennsylvania,
HOWARD E. MOSES, Harrisburg, Pa.

Engineers' Society of Western Pennsylvania,
A. F. TRESCHEW, Pittsburgh, Pa.

Florida Engineering Society,
L. R. MCLAIN, St. Augustine, Fla.

Grand Rapids Engineering Society,
GARDNER S. WILLIAMS, Ann Arbor, Mich.

Illuminating Engineering Society,
WALTER C. ALLEN, Washington, D. C.

Indiana Engineering Society,
H. O. GARMAN, Indianapolis, Ind.

Institute of Radio Engineers,
MAJ. GENERAL GEORGE SQUIER, Washington, D. C.

Iowa Engineering Society,
JOHN H. DUNLAP, Iowa City.

Kansas Engineering Society,
LLOYD B. SMITH, Topeka, Kansas

Los Angeles Joint Technical Society,
GEORGE G. ANDERSON, Los Angeles, Cal.
W. K. BARNARD, Los Angeles, Cal.

Mohawk Valley Engineers' Club,
BYRON E. WHITE, Utica, N. Y.

National Fire Protection Association,
SAMUEL J. PRESCOTT, Washington, D. C.
IRA H. WOOLSON, New York City

Nashville Engineering Association,
W. G. WALDO, Chattanooga, Tenn.

Northeastern Water Works Association,
LEONARD METCALF, Boston, Mass.

Oregon Technical Council,
DAVID C. HENNY, Portland, Ore.

Providence Engineering Society,
J. C. HALL, Providence, R. I.

San Francisco Joint Council of Engineering Societies,
C. E. GRUNSKY, San Francisco, Cal.

Scientific Club, Indianapolis,
W. A. HANLEY, Indianapolis, Ind.

Society of Automotive Engineers,
COKER F. CLARKSON, New York City
HOWARD E. COFFIN, Detroit, Mich.
CHARLES M. MANLY, New York City

Society of Industrial Engineers,
L. W. WALLACE, Baltimore, Md.

Society for Promotion of Engineering Education,
ARTHUR M. GREENE, JR., Troy, N. Y.

Society of American Military Engineers,
JOHN H. FINNEY, Washington, D. C.

Taylor Society of New York City,
HARLOW S. PERSON, New York City

Technical Club of Dallas,
C. H. KOCH, Dallas, Tex.

Topeka Engineers' Club,
LLOYD B. SMITH, Topeka, Kansas

Vermont Society of Engineers,
GEORGE A. REED, Montpelier, Vt.

Washington Society of Engineers,
M. O. LEIGHTON, Washington, D. C.

American Society of Mechanical Engineers,
L. P. ALFORD, Chairman, New York City
N. S. CARMAN, Cleveland, Ohio
R. H. FERNALD, Philadelphia, Pa.
W. B. GREGORY, New Orleans, La.
W. A. HENLEY, Indianapolis, Ind.
D. S. KIMBALL, Ithica, N. Y.
L. C. NORDMEYER, St. Louis, Mo.
V. M. PALMER, Rochester, N. Y.
N. P. PORTER, Tulsa, Okla.
ARTHUR L. RICE, Chicago, Ill.
CALVIN W. RICE, New York City
PAUL WRIGHT, Birmingham, Ala.

Association of Railroad Engineers,
LEWIS S. BILLAU, Baltimore, Md. (unofficially)

Engineers' Club of St. Louis,
WM. E. ROLFE, St. Louis, Mo.

Engineers' Club of Trenton,
JAMES E. ENGLISH, Trenton, N. J.

Engineering Council,
CHARLES WHITING BAKER, New York City
M. O. LEIGHTON, Washington, D. C.

Illinois Society of Engineers,
L. K. SHERMAN, Washington, D. C.

Engineering Society of Akron,
FRED E. AYER, Akron, Ohio

Detroit Engineering Society,
D. JAMES STERRETT, Detroit, Mich.

Total Societies 61
Total Delegates 123

combined with those of others and made more effective and whereby it would be assisted in matters of state and national scope. This point of view was concurred in by J. F. Oberlein, for the Cleveland Engineering Society, J. C. Hall for the Providence Engineering Society, W. E. Rolfe for the Associated Engineering Societies of St. Louis, and others. That the federation idea was nothing new was pointed out by L. W. Wallace, of the Society of Industrial Engineers. He cited the cases of affiliations of local associations which had done successful work at Cleveland, St. Louis, and Indianapolis. Co-ordination, he believed, could best be accomplished by societies, and not by individuals.

The opposite viewpoint was taken by George W. Fuller, consulting engineer, of New York, representing A. A. E. "It is not practicable," said Mr. Fuller, "for a group of national societies to be organized from the top down. The confederation idea has not proved successful in this country." The A. A. E., Mr. Fuller pointed out, was organized from the bottom up, was a going concern, and one which, by interesting itself in the problems of the young engineer, had done effective work in removing the menace of labor unionism in engineering circles. Speaking along similar lines, W. J. H. Strong called attention to the apparent financial weakness of the proposed federation and made the definite statement that whether or not a federation was formed, the American Association of Engineers would continue with its present work.

In this discussion delegates from the smaller engineering societies and the A. A. E. contingent were very active. While opinions differed radically, there was never at any time throughout the conference any show of ill will or antagonism. The A. A. E. delegates, one after one, made a persistent and forceful presentation of their case, but it was clear, as time went on, that the sweep of opinion was toward the federation and against the acceptance of the American Association of Engineers as a substitute for a national affiliation of engineering interests by societies instead of by individuals.

A. A. E. Votes "Aye"

After the current of discussion had ebbed and flowed for several hours, the first dramatic incident of the conference was staged when a roll-call vote on the Williams resolution was demanded. By an odd twist of circumstance the pivotal organization, the American Association of Engineers, would, according to the alphabetical listing of the delegations on the official roster, have to cast the first vote. As Chairman Townley turned to Secretary Hoyt with the order, "Proceed with the roll call," an expectant hush settled upon the gathering.

"American Association of Engineers," called the Secretary.

President L. K. Sherman, of A. A. E. rose. The only sound that broke the stillness in the auditorium was the creaking of the wooden seats as delegates leaned forward in order that no word of the reply should escape them.

"The American Association of Engineers, seventeen delegates, votes aye!" announced Mr. Sherman.

A storm of applause greeted this declaration. The A. A. E., fighting gamely, had sensed the trend of opinion and had, in a spirit of true sportsmanship, cast a vote which would not obstruct the objects of the majority. In the noisy confusion which followed some one moved "to dispense with the further calling of the roll," but after the meeting had calmed down the names of all delegations were read and unanimous endorsement was given to the principles of the creation of the federation and its organization by societies, not individuals.

The conference had made a momentous decision.

The passage of the Williams resolution marked the first milestone in the progress of the conference toward its goal. The secretary's canvass showed that 119 votes in favor of the measure were cast, there being no negative votes; of the 57 societies represented at this session by delegates, 5 societies did not vote. The way having been opened for the organization of the conference, Chairman Townley named three large committees, the first on constitution and by-laws, R. L. Humphrey, chairman; the second, on resolutions, Philip N. Moore, chairman; the third, on program, R. H. Fernald, chairman. Each of these committees consisted of about 25 members. They were made purposely large, Chairman Townley stated, in order that thoroughly representative opinion could be secured.

Constitution Approved

Inasmuch as the essential business of the conference was organization on definite lines, interest centered principally upon the report of the Committee on Constitution and By-laws which was submitted by Chairman Humphrey on the morning of June 4. The committee's recommended constitution was approved by the conference substantially in its original form, in spite of a lengthy discussion on details. The main features of the adopted constitution—which is subject to editorial revision follow:

The name of the new organization is "The Federated American Engineering Societies." Its object is "to further the interests of the public through the use of technical knowledge and engineering experience, and to consider and act upon matters common to the engineering and allied technical professions."

Membership—The membership is to consist of national, local, state, and regional engineering and allied technical organization and affiliations. The management of the organization is vested in a body designated as the American Engineering Council and an executive board of that body. The council is to consist of representatives of every member society. Each national, state, regional or local organization is entitled to one representative on the council for a membership of from 100 to 1,000 inclusive, and one additional representative for every additional 1,000 members or major fraction thereof. The duties of the council are to co-ordinate the activities of state councils and of local affiliations whenever these activities shall be of national or general importance, or affect the general interest of engineers. It is specified that no organization shall have more than 20 representatives on the council.

Officers—The elected officers of the council are to consist of a president, to hold office two years and to be ineligible for re-election, four vice-presidents, to hold office for two years (two to be elected every year), and a treasurer, to hold office for one year. These officers are to be elected by letter ballot of the representatives of the member societies on the council. There will be an executive officer, with the title of secretary, appointed

by and holding office during the pleasure of the executive board. The secretary will not be a member of the executive board but may be a representative on the council.

Management—The general management of the affairs of the Federated American Engineering Societies is to be in an executive board of 30 members of the council, of whom 6 shall be the officers and 24 shall be selected, a part by the national societies and the remainder by the local, state, or regional organizations, according to districts. It is planned to have the national and local organizations represented on the executive board in the ratio of their membership in the council.

Funds—The constitution provides that the funds of the organization shall be provided on the basis of $1.50 per member for national societies and $1 per member for local, state, or regional organizations. The formation of local affiliations and state councils is provided for.

Authority—Under the section "Authority" the constitution provides as follows: "Local affiliations, state councils and the American Engineering Council shall deal with local, state, and national matters respectively and they shall be autonomous with respect thereto. It shall, however, be the duty of the American Engineering Council to interest itself in the activities of local affiliations and state councils if such activities are of national scope or affect the general interest of the engineering and allied technical professions; provided that nothing herein stated shall be construed as preventing the discussion by any local affiliation or state council or by the American Engineering Council of any matters of interest to engineers and members of allied technical professions for action by the said Council on local or state matters where no local affiliation or state council exists."

Publicity—There is also a definite provision in the constitution favoring a policy of publicity and close co-operation of the federation with the technical press.

A. A. E. "Present but Not Voting"

When the acceptance of the constitution was put to a roll-call vote interest again centered on the action of the American Association of Engineers, particularly in the light of its endorsement of the Williams resolution presented at the first day's session. When the first name on the list was called Mr. Strong explained that, before announcing his organization's position, he wished to make a statement in order that any misconception might be avoided. The affirmative vote on the Williams resolution, Mr. Strong said, was cast in order that the A. A. E. might not appear in the light of an obstructionist. He explained that entry into the Federated American Engineering Societies would require a payment by A. A. E. of about $30,000. The association felt that it was not justified in turning over this sum for welfare work which it believed its own machinery was able to handle effectively. Mr. Strong further explained that a proposal made to the Organizing Conference and providing for the assignment of all welfare work of the new organization to the American Association of Engineers had been rejected, as had also a tentative offer of appropriations by A. A. E. for certain specific purposes. Nevertheless, it was maintained that the attitude of the American Association of Engineers toward the new federation would be one of co-operation. Future developments may indicate, said Mr. Strong, that the two organizations may be needed and the time may come when an amalgamation may be considered. For the present, however, the American Association of Engineers could not endorse the constitution and by-laws for the new federation and Mr. Strong requested that the secretary record the American Association of Engineers as "present but not voting."

Practically all of the other organizations represented by delegates at the conference endorsed the constitution. There were 88 affirmative votes, none negative; eight societies went on record as "present but not voting," and ten were "absent." The secretary's list showed that on the final day of the meeting 61 engineering organizations had registered, with 123 delegates; After the constitution was unanimously adopted a set of by-laws also was endorsed. It was explained by Mr. Humphrey that the constitution had purposely been made short and simple, and that details as to the administration of the new federation could be taken care of by provisions in the by-laws as the need for them became apparent.

Resolutions Approved

The conference endorsed three measures submitted by the Committee on Resolutions, the first urging an increase in salary for engineering educators; the second, a prompt enactment of legislation which would put into effect the salary readjustments provided for in the report of the reclassification committee on salaries for Government employees at Washington; and the third endorsing the creation of a Federal Department of Public Works.

Inspirational Addresses

The sessions of the conference were divided into two general classes: The first, business sessions, had to do with ways and means of bringing the new federation into existence. The second group was devoted largely to addresses of an inspirational character designed to indicate to engineers fields for activity in the interest of public welfare and matters of concern to the profession which should receive attention by the federated organization.

In a forceful address at the afternoon session of June, 3, Arthur P. Davis, president of the American Society of Civil Engineers, made a plea for united action by engineers, and pointed out the tremendous prestige which a federation of engineering societies would carry, not only because of the great membership of more than 100,000 represented, but on account of the combined high technical attainments of such an all-inclusive membership. High technical standards, however, Mr. Davis believed, should have no part in the reuirements for membership in the new federation.

Philip N. Moore, past-president, American Institute of Mining and Metallurgical Engineers, endorsed the federation of engineering societies as offering a medium to engineers for speaking on matters of national import. Himself a member of Engineering Council, Mr. Moore pledged the support of that organization to the new federation. "Engineering Council," said Mr. Moore, "is ready to turn its work over to any organization that will do it better than it has been done in the past." All efforts toward the success of the new federation, Mr. Moore contended, will be in vain unless the

individual societies give it their active support.

Thomas H. McDonald, chief of the U. S. Bureau of Public Roads, after presenting a brief review of the financial condition of the Federal-aid road program, pointed out that an organization such as the Federated American Engineering Societies could do a great work by bringing its influence to bear in opposition to any policy which classified the construction and maintenance of public highways as non-essential work, and therefore not entitled to recognition in the delivery of materials by the railroads.

William D. Uhler, chief engineer, Pennsylvania State Highway Department, spoke on the economic value of good roads.

The Engineer in Business

Three addresses were delivered at the evening session, June 3, in the grand ballroom of the New Willard. Homer L. Ferguson, past-president, U. S. Chamber of Commerce, urged upon engineers the development of the business point of view. They have practically all of the qualifications for becoming business men, according to Mr. Ferguson, except the one of "thinking on their feet." It was insisted that engineers must become better public speakers. Undue reticence is the main trouble, said Mr. Ferguson. "It is not unusual," continued Mr. Ferguson, "for engineers, when they get up to speak, to act as if they had a gold brick to sell." Speaking of the objects and the opportunities of the federation of engineering societies, Mr. Ferguson made this significant remark: "You won't have much of anything these days unless the voice of your business or profession is heard."

Publicity for Engineers

The second address of the evening, "Publicity for Engineers," was delivered by James H. McGraw, president, McGraw-Hill Co., Inc., New York. "I am here," said Mr. McGraw, "because I see in this meeting one of the most forward steps that have been taken by engineering organizations in their history." One of the most constructive acts the federated societies could perform, Mr. McGraw pointed out, would be to visualize the opportunities for publicity for the engineer and perfect methods of securing this publicity. The public is now conscious of the engineer as a servant, but Mr. McGraw contended that he should be regarded as a leader, as a man upon whose thinking our national life depends. Service to the nation, said Mr. McGraw, is what the engineer has to advertise, but before reaching his ultimate place in public esteem he must become a better business man, leave behind the narrowness that goes with a specialized kind of thinking, and give expression to the idea that he is the man who makes our present life possible. In other words, the engineer must be human as well as an engineer. The technical press, according to Mr. McGraw, is behind the engineering societies and their developments. He made an emphatic plea for complete understanding and co-operation between the engineering societies and technical and business papers.

The evening's program was concluded by an address on "The Engineer and National Prosperity," by Dr. George Otis Smith.

The final session of the conference on the evening of June 4, after the business had been concluded by the approval of the constitution and by-laws, was made notable by an address on "The Executive in Engineering," by Samuel M. Vauclain, president of the Baldwin Locomotive Works. Mr. Vauclain presented an intimate picture of the problems which face an executive in a great manufacturing plant and touched upon many of the human phases of industry. The really great executive in engineering, as defined by Mr. Vauclain, is the man "who has confidence not only in himself but in those whose work he directs."

Other addresses were made by Robert S. Woodward, president, Carnegie Institute, Washington, D. C., and James R. Angell, chairman, National Research Council. Both of the evening sessions at the Willard Hotel were followed by smokers at which the delegates to the Organizing Conference were the guests of the Washington Society of Engineers.

Resolutions of Appreciation Passed

The two-day session concluded with resolutions of appreciation of the work done in organizing the Federated American Engineering Societies by Richard L. Humphrey, chairman of the Joint Conference Committee, and Calvert Townley who was chosen chairman of the Organizing Conference at its first session and presided at all meetings during the two-day period.

There is given on p. 1138 the complete list of national, state, and local engineering organizations participating in the conference, together with the names of their delegates. The final count shows that 61 organizations, represented by 123 delegates, took part in the Washington meeting.

Carnegie Educational Foundation Makes Annual Report

In the fourteenth annual report of the Carnegie Foundation for the Advancement of Teaching, recently made public there is shown total resources of $21,643,000, representing the permanent general endowment of $13,150,000, the endowment of the division of educational enquiry of $1,250,000, and three reserve funds. One reserve fund, now amounting to $6,512,000 and increasing at the rate of six hundred thousand dollars a year, is to be spent, principal and interest, in the retirement during the next sixty years of the six thousand teachers now in the associated institutions. Another reserve fund, now a third of a million dollars, is to be accumulated to one million dollars and expended, principal and interest, in aiding universities and colleges to adopt the new plan of contractual contributory annuities inaugurated by the Foundation during the year.

Of the total expenditures, $5,600,000 went to the associated list of 73 institutions. The report indicates the appropriation to each of these institutions during each year of the foundation's history. Harvard has reecived a total of $556,000; Yale $491,000; Columbia, $405,000; Cornell, $326,000; Amherst, Johns Hopkins, Massachusetts Institute of Technology, Princeton, Stevens Institute of Technology, Tulane University, the universities of California, Michigan, Minnesota, Missouri, and Wisconsin, each received more than $100,000, the average for these eleven institutions being $130,000.

The resources of the foundation were increased during the year by three and one-third million dollars, two and one-half million from the Carnegie Corporation and the remainder from accumulated income.

Design of Dams and Auxiliary Structures of Miami Conservancy District

Final Proportioning of Earth Dams — High Retaining Walls Governed by Base Pressure — Outlet Conduits — Lining of Jump Pools — Three-Hinged Arch Bridges and Continuous Girder Spans of Concrete

VARIOUS difficult problems of structural design were encountered in developing the flood-protection plans of the Miami Conservancy District, whose operations extend along the Great Miami River from Sidney to Hamilton, in southwestern Ohio. Three years ago, when the official plan of the district had just been formulated and had received court approval, we were able to present a summarized description of the project as a whole and of the principal elements of its retarding-basin work. During the subsequent preparation of bidding plans and while getting ready to begin construction, the engineers of the District made modifications in numerous details of the original designs, but the essential description of the structures as previously given (see *Engineering News*, Jan. 25, 1917, pp. 144 to 151) remains without change. It has since been possible to obtain from the designers information as to the reasoning and analyses on which the proportioning of the dams and auxiliary structures was based. A condensed statement of the methods is given in the following, with special reference to the features of departure from precedent or ordinary procedure.

The five dams of the District range from 73 to 124½ ft. in height from stream bottom to crest; their length ranges from 1210 to 6400 ft. Being located in populous valleys, they were required to be proportioned with unusual regard for safety. Further, they will be dry during many years at a time, except for occasional wetting of their lower portions in flood time and such saturation as may result from rainfall. The effect of this condition on their stability and tightness could not be foreseen with certainty, and it seemed wise to provide for increase of section to allow for it. On the other hand there were strong reasons for seeking economy: not only the magnitude of the enterprise and the length of the dams, but also the necessity for completing each embankment in the shortest possible time in order that its valley might be closed without creating abnormal hazards during construction.

The design finally settled upon, shown in Fig. 2 herewith, represents slight changes from that shown in these pages three years ago, as already referred to. The section is distinctly more ample than that of other high embankments of admittedly conservative design, as, for instance, those of the Board of Water Supply of New York City. The cross-section is marked by the use of frequent benches to interrupt the side slopes, by concave sides whose slope flattens from 2:1 at the top to 3½ or 4:1 at the base, by grassing of both slopes, and by thorough provision for drainage of the slopes to prevent wash.

With respect to interior structure, all of the dams were designed to have a central portion of impervious material, integrally joined with the outside portions, built of coarser material. Originally, three methods of construction were considered as alternatives: Hydraulic deposition, dump deposition with hydraulic sluicing of the finer material into final position, or wholly dry construction by dumping, spreading and rolling. More than a year later, when it was decided that construction would be done by force account, the District adopted the hydraulic method for all five dams. At this stage

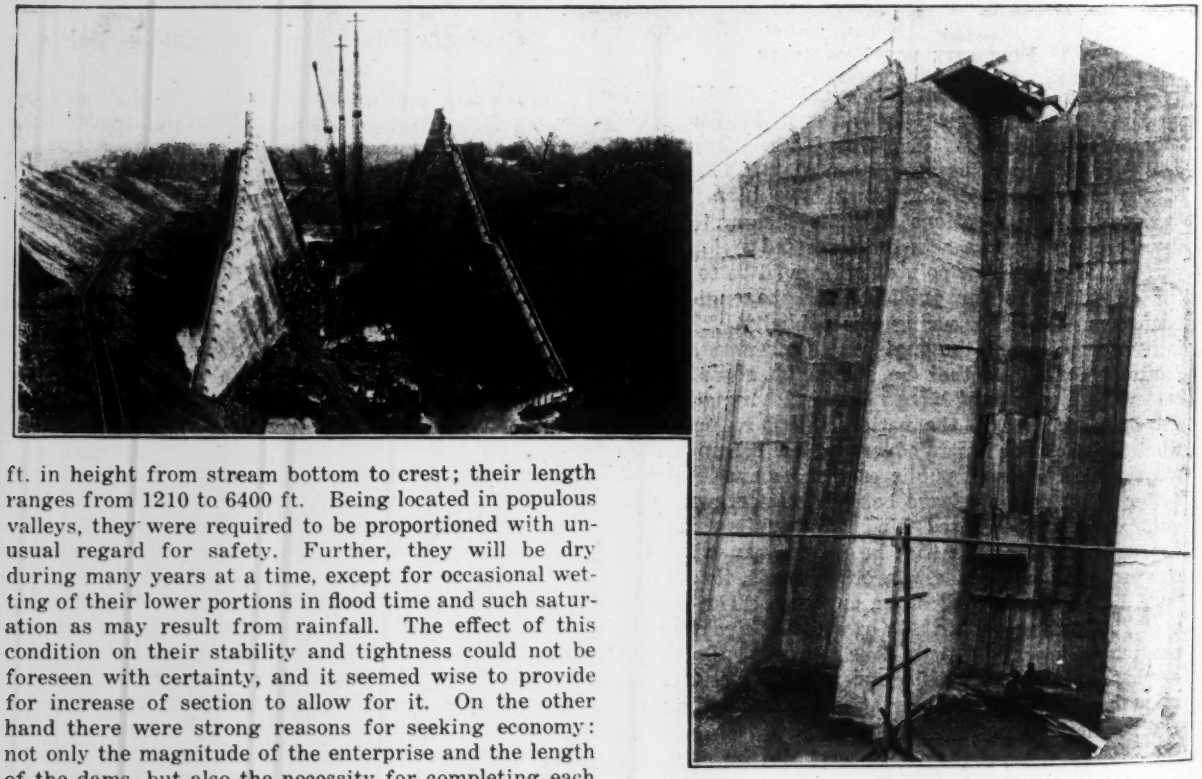


FIG. 1. RETAINING WALLS AT LOCKINGTON—BACK OF WALL GROOVED FOR BOND WITH EMBANKMENT; CUTOFFS INDEPENDENT OF WALL BUT NOTCHED IN

the question of core width and structure assumed great importance. Principles were therefore formulated with respect to holding the core width at the base to an amount not exceeding the final dam height above the point in question, and controlling the grading of materials in core and banks (by control of the mechanical analysis of the material pumped in). The governing line of thought, and a series of experiments and field observations to fix on grading of material and get a check on the core consolidation, were described in an article entitled "Study of Pressures in Hydraulic Dam Cores" in *Engineering News-Record* of Dec. 25, 1919, pp. 1040-1044.

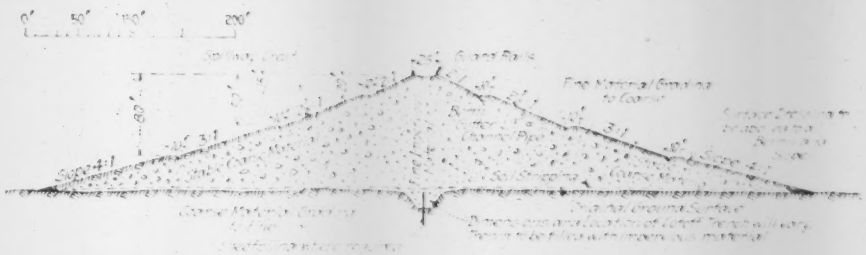


FIG. 2. FINAL DAM SECTION OF MIAMI CONSERVANCY DISTRICT (TYPICAL)

On account of the necessity of carrying up the embankment on either side of the stream-control gap before the outlet structures (conduits or spillway dams) are completed and before the stream can be diverted through them, and also to avoid interference with railway lines and roads before completing their relocation, the embankment is terminated at the outlet works or at the stream bank or side of railway right-of-way, as the case may be, by a cross dike until the closure section can be filled in. The cross dike introduces a structural irregularity into the hydraulic embankment but in building it the finest material is placed along that part corresponding to the core of the finished dam, and it is believed thorough bonding is secured.

As the valley bottoms of the Miami area consist of gravel and sand lying in relatively deep glacial gorges, it was considered necessary to take special care to safeguard against shortcircuiting of water flow. Therefore the stream bed, which was generally exposed gravel, was covered (after cleaning) with a minimum of 4 ft. of tight material, rolled. Elsewhere over the dam site the soil was explored by test pits here and there, and where gravel was found at less depth than 3 ft. sufficient rolled fill was placed on the surface to give a 3 ft. minimum thickness of seal (in the case of the two high dams, Englewood and Germantown, 4 ft.).

The cut-off trench along the center line of the dam, which extends across the width of the valley and up the sides to spillway level, was filled with core material by hydraulic deposition between the upper and lower toe embankments. Thus the cut-off consists wholly of fine material. The depth of this cut-off was fixed by judgment; a tight seal stratum can not be reached.

Retaining Walls of Great Height

Of the five dams, the two highest are full-length embankments pierced by twin concrete culverts or outlet conduits for discharging both the normal stream flow and the flood discharge from the filled basin, and protected each by a spillway remote from the outlet conduits. The other three dams (Huffman, Taylorsville, and Lockington, 73 to 84 ft. high) have the spillway and outlet combined in a single concrete dam built into a large concrete notch which interrupts the embankment. Such a spillway notch consists of (1) retaining walls terminating and holding the embankment section on either side, (2) a concrete overfall dam built between these walls and pierced by the discharge conduits for stream and flood flow (the spillway crest will come into action only in the most extreme flood contingencies and serve chiefly to give definition to the maximum flood detention level of the basin), and (3) concrete pavements upstream and downstream of the weir, the downstream section leading into the basin in which the outflow energy is dissipated by a hydraulic jump. It will be seen that the spillway-notch construction involves retaining walls of great height. From foundation to dam, crest these walls are 78 ft. high at Huffman, 83 ft. at Taylorsville, and 84 ft. at Lockington. They must be stable without support from the spillway weir.

In dealing with the difficult design problem presented by these retaining walls, it soon appeared probable that the vertical load on the base would be a limiting factor, in view of the available foundation material. In the

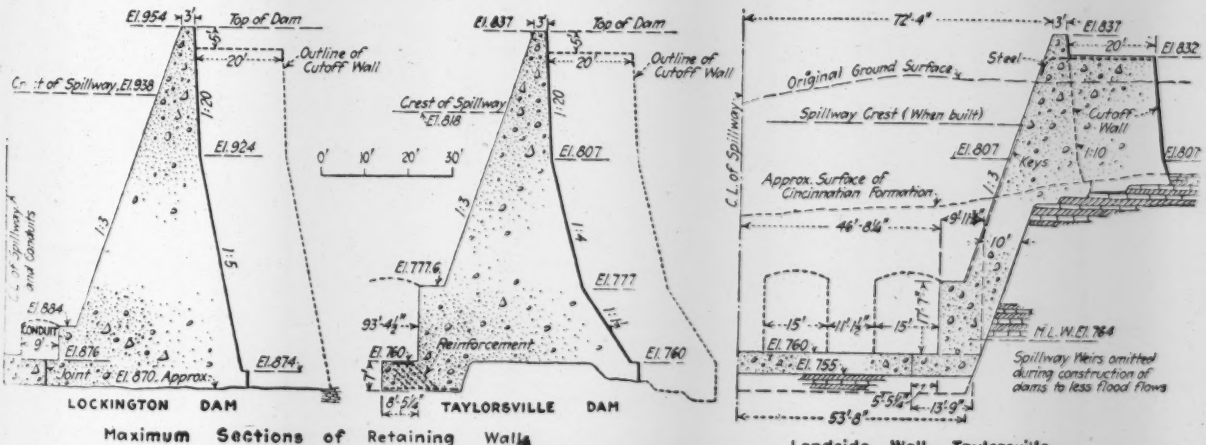


FIG. 3. LOCKINGTON AND TAYLORSVILLE SPILLWAY-NOTCH WALLS AT MAXIMUM SECTION (83 AND 84 FT. HIGH), AND LANDSIDE WALLS AT TAYLORSVILLE

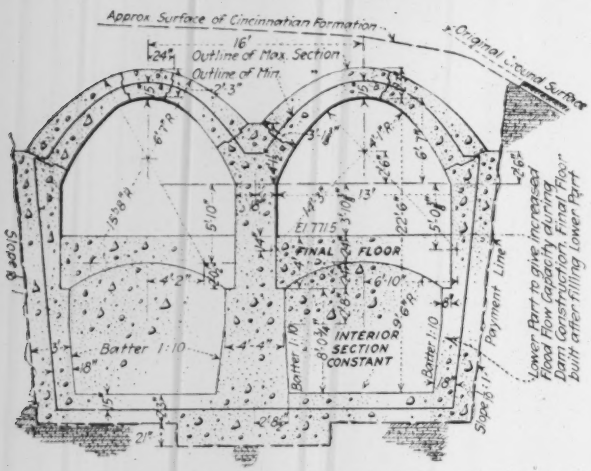

Approx. Surface of Cincinnatian Formation
Original Ground Surface
Outline of Max. Section
Outline of Min. "
FINAL FLOOR
INTERIOR SECTION CONSTANT
Batter 1:10
Batter 1:10
Batter 1:10
Slope 8:1
Payment Line
Lower Part to give Increased Flood Flow Capacity during Dam Construction. Final Floor built after filling Lower Part

FIG. 3. ENGLEWOOD DISCHARGE CONDUITS, WITH OUTLINE OF MAXIMUM AND MINIMUM SECTIONS

sequel the entire design was governed by the necessity of limiting the foundation pressure, as will be explained.

The spillway and outlet structures are in all cases founded on rock; and it was in fact the contour of rock surface that fixed the location of the outlet structures. At all except one of the dams, Lockington, the rock is the Cincinnatian formation of the Miami region, a deposit consisting of alternate layers of limestone and shale (really partly consolidated clay). The clay appears hard and permanent when first exposed, but contact with air and water soon causes it to slack into the condition of a rather tough, slippery, plastic clay. The layers range in thickness from a fraction of an inch to a foot or more, and in no case are the limestone layers thick enough to be considered independent of the shale laminae. The conclusion was drawn that, with regard to the possibility that the shale layers might become softened and under heavy loading squeeze out, it would not be wise to exceed a loading of 6 tons per square foot. At Lockington, where a massive limestone without shale interleaving is found, 12 tons per square foot was adopted as the pressure limit.

With these very low limits of base pressure, the wall design became exceedingly difficult. Every effort was required to limit the maximum base pressure. One other factor controlled the design: The consulting board of engineers of the district decided early in the course of the planning of the flood-protection works that reinforced concrete should not be used in any vital structure above permanent water level; a vital structure was defined as one whose failure would endanger life or affect the stability of other works. Under this ruling it was necessary to design the retaining walls as gravity walls, except that reinforcement might be used in the very lowest sections, below stream level.

Since the shape of the spillway notch did not impose close limits on the face batter of the walls, a batter of 1 in 3 was adopted. For given base width the maximum foundation pressure is less if the median line of the wall leans backward than if it is placed vertical or leaning forward. With the adopted face batter as starting point, the wall was analyzed at successive elevations to determine the required thickness to resist the embankment pressure. These analyses led to shaping the back of the wall to a generally concave outline, comprising three batters, as shown in the cross-section Fig. 3. The concave back further tended to hold down the foundation pressure at the toe of the wall. Finally, however, it proved necessary, in order to hold to the limit of six tons at the toe, to extend the toe beyond the face as a reinforced cantilever, in the case of the Huffman and Taylorsville walls; for the latter the maximum toe projection is 6 ft. At Lockington, on account of the higher permissible loading, no toe extension was required, and the back of the wall was shaped to but two batters.

All these calculations were based on the maximum estimated pressure of the core fill, under conditions prevailing during construction. Because this material will consolidate, decreasing the lateral pressure, it is believed that the computed stress and load conditions are temporary. Fully as important, however, is the fact that the Cincinnatian formation was found to be of considerably better character in the actual foundation pits than it was assumed to be, from the exposures and test pits, and at the present time it is thought that a footing pressure of 8 tons or more might have been used in the design without danger. This conclusion is considered specially dependable because of two facts: (1) the strata receiving the footing loads are under considerably higher pressure from overburden in the natural hillsides at the end of the dam, and (2) the soil under the main embankment of the dam itself is loaded to the assumed footing pressure.

Fixing upon the value of lateral earth pressure to be adopted for the calculations, in the case of the hydraulic core backing of the retaining wall, gave rise to some interesting considerations. For the case of true hydrostatic pressure of mud against the wall, it was concluded that the lateral pressure of a liquid weighing 87 to 90 lb. per cubic foot might have to be reckoned with, as some evidence was found to indicate that truly liquid mud might be of this weight. It was not considered possible, however, that the liquid condition could exist for the full height. As an extreme condition it was thought that hydrostatic pressure might exist for the upper half and pressure from partly consolidated material in the lower half of the wall. It was not necessary to consider either the condition of liquid fill for part of the height of the wall, or the permanent condition of a semi-consolidated fill, weighing 125 lb. per cubic foot or more but exerting a lower lateral pressure; only the critical conditions occurring during construction needed to be taken into account. With regard to this, the final conclusion was that the design should be made for an intensity of horizontal pressure equal to 75 lb. times height to top of fill, and for a vertical pressure equal to 100 lb. times the height. In a limited zone at the center line of the dam a liquid pressure of 90 lb. per cu.ft. was assumed for the top 30 ft. of height. In the portions of the wall holding the toes of the dam, a material reduction in lateral pressure was assumed. Beyond this point the procedure followed ordinary wall-design methods. The maximum compression in the concrete was limited to 500 lb. per sq.in. (with occasional excess). Longitudinally, the wall was cut by an expansion joint every 30 ft. and the sections keyed together by vertical tongue-and-grooving. Variations in wall dimensions were made in general only from section to section, the footing dimensions and all but the back batter of the upper

part of the wall being held constant within any expansion section.

Several cut-off walls project from the back of each retaining wall to bond into the embankment, as may be seen in Fig. 1. These are in all cases built on separate foundations and concreted separately from the wall, but are notched into the wall to a depth of 12 in. for stability and tightness. They are also tied at the top to the retaining wall by reinforcing steel.

Grooving the back of the main retaining wall for closer bond with the embankment soil was tried at Lockington, the nature of this grooving being shown by one of the views. It is believed to be an advantageous modification and will be used in building the Taylorsville walls. The view of the Lockington wall also shows a concrete chimney for pool drainage built against the back of the wall; this will be provided at all three dams.

Landside Walls—An unusual modification of wall construction was required on the land side of the Taylorsville spillway notch, which abuts directly against the hillside rock. In those portions of this wall where the rock face extends to the top of the wall the concrete will constitute only a facing or revetment; here the face of the excavation has been cut to a batter of 1 in 3 to the top of the facing, and this will also be the batter of the facing, while above the top of the concrete the rock is cut to a slope of ½ in 1 and will not be faced. In its central portion, however, the landside wall extends for a considerable height above rock. Here it is built to the cross-section typically represented in Fig. 3. Lateral pressure of the backing acts only above the rock line. From the toe of the upper section of the wall, compression is assumed to travel down the lower leg to bring an evenly distributed loading on the footing and toe projection.

The backs of the landside walls were provided with a vertical drain in each 30-ft. section. The high retaining walls holding the main dam are not drained.

Very high water velocities and much turbulence and impact will exist within the spillway notch and in the jump pool directly downstream from it, when flood discharges pass down. It was believed that these actions in so far as they affect the pavement will be resisted by the weight of the pavement without anchoring. The thickness of the concrete here was determined initially on the basis of a hydrostatic uplift equal to half the difference between lowest water surface at the point in question and the simultaneous water level below the outlet works. However, the thicknesses so found were increased to suit practical requirements. The greatest floor thickness will be that in the jump pool at Taylorsville, 9 ft.; in the spillway notch generally and at the downstream end of the jump pool the pavement will be of minimum thickness, 2 ft.

Discharge Conduits

The outlet conduits of the Germantown and Englewood dams are twin arch culverts under an earth loading ranging from nothing at their ends to about 115 ft. at midlength. As the water flowing through them at maximum flood will occasionally reach velocities exceeding 50 ft. per second, structural defects would be particularly serious. Not merely stability but also rigidity sufficient to guarantee against any local elastic failure was therefore important.

The foundations are on rock throughout, the Cincinnatian formation already referred to; the footing pressure was limited to 6 tons per square foot as in the case of the Taylorsville and Huffman retaining walls. While settlement was not to be apprehended, the great range of loading nevertheless made it important to forestall large differences in the elastic distortion of the structure. For this reason four different cross-sections were used (Fig. 5); for example, at Germantown the crown thicknesses of the arch are 18, 21, 24, and 27 in., the latter being for 110 ft. embankment height.

The following general assumptions governed the design of the long conduits: (a) The weight upon the conduits will be that of the material included between the vertical planes passing through the boundaries of the structures. (b) The embankment weighs 125 lb. per cu.ft. (c) The ratio of horizontal to vertical pressure in the fill is estimated at ½. Under temporary conditions this might be sometimes exceeded, and consequently in certain cases the horizontal pressure is taken as the full hydrostatic pressure due to the maximum level of water

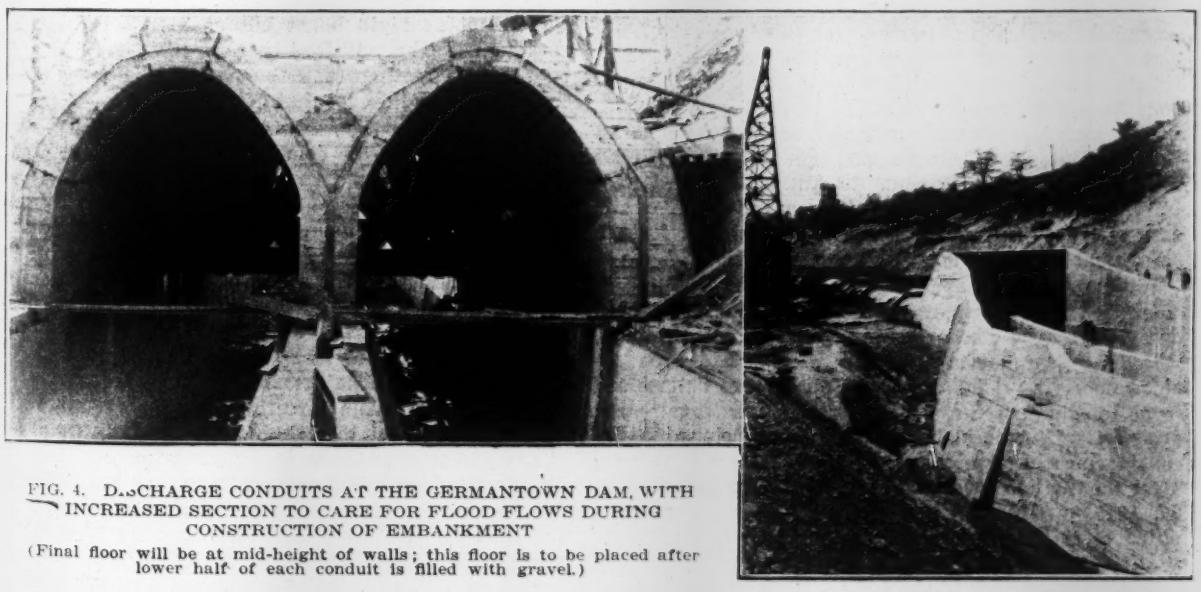


FIG. 4. DISCHARGE CONDUITS AT THE GERMANTOWN DAM, WITH INCREASED SECTION TO CARE FOR FLOOD FLOWS DURING CONSTRUCTION OF EMBANKMENT

(Final floor will be at mid-height of walls; this floor is to be placed after lower half of each conduit is filled with gravel.)

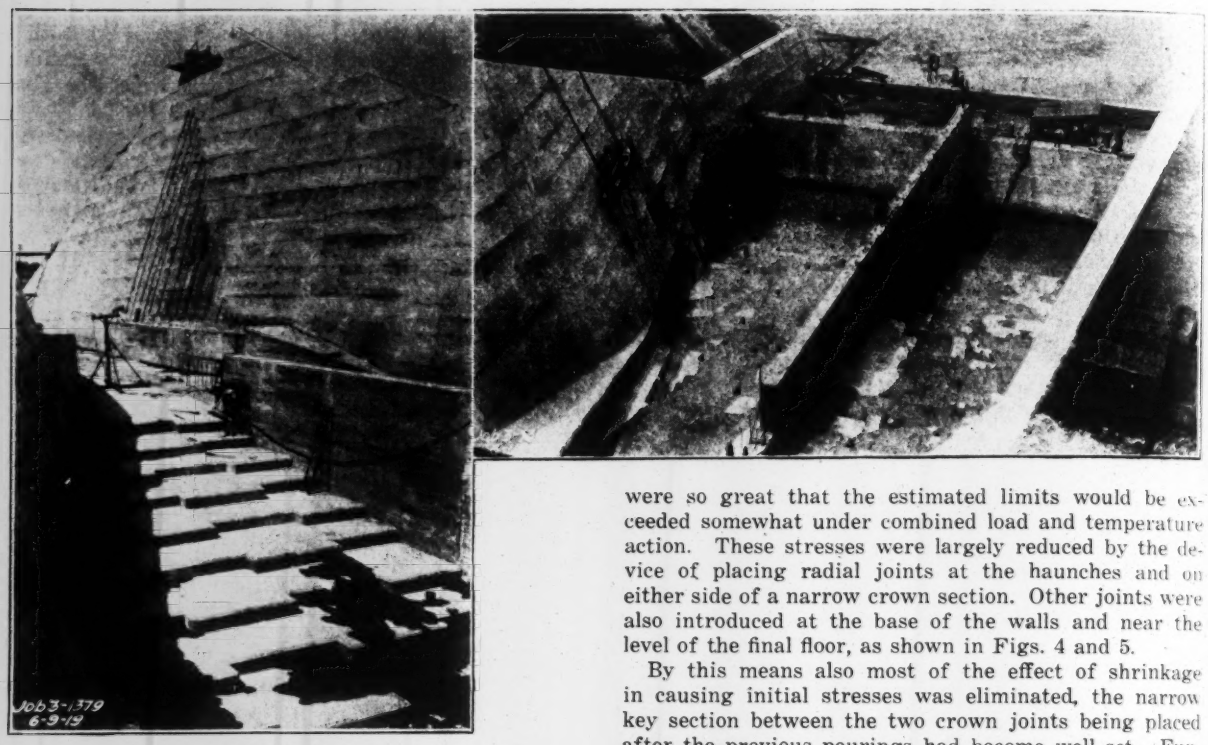


FIG. 6. UPPER AND LOWER PORTIONS OF LOCKINGTON JUMP POOL

in the basin. (d) Temperature stresses are to be calculated for rise of 32.5 deg. and a fall of 65 deg. F. (e) Compression stresses on the concrete are to be limited to 500 lb. per sq.in. for any conditions of permanent load. Temporary stresses, including the effects of extreme temperature changes, are to be limited to 750 lb. per sq. in. in compression, disregarding tensile stresses in the concrete. (f) No reinforcing steel will be used in the arches of the conduits nor shall there be tensile stresses in the concrete for any probable permanent condition of load. (g) The portion of the conduits from the center of the dam to the inlet shall be designed for a permanent condition of earth cover only, with the horizontal component of pressure equal to $\frac{1}{3}$ of the vertical, but shall also be safe for the following temporary conditions; first, with water within 5 ft. of the top of the dam, conduit closed, horizontal component of pressure equal to $\frac{1}{3}$ of vertical; second, same condition except horizontal component of pressure equal to full hydrostatic pressure. The portion of the conduit from the center of the dam to the down-stream end shall be designed for the permanent condition only.

With regard to shape of cross-section, hydraulic considerations were primary, since the structures are to carry large flood discharges at high velocity. However, when the general shape of the interior had been decided upon, the details of the section were determined so as to minimize the stresses from the external earth pressure. In general the stresses were determined by considering the arches as continuous elastic structures after the method developed in *Engineering Record*, May 22, 1915, p. 648. The temperature stresses were computed in the manner usually followed in treatment by the elastic theory.

It was found that in some cases temperature stresses were so great that the estimated limits would be exceeded somewhat under combined load and temperature action. These stresses were largely reduced by the device of placing radial joints at the haunches and on either side of a narrow crown section. Other joints were also introduced at the base of the walls and near the level of the final floor, as shown in Figs. 4 and 5.

By this means also most of the effect of shrinkage in causing initial stresses was eliminated, the narrow key section between the two crown joints being placed after the previous pourings had become well set. Furthermore, by the time the crown section was placed the previous sections would have had time to reach something near their probable mean temperature. The presence of the joints permitted in general a certain freedom of adjustment of the structure to the later effects of shrinkage and temperature change. (The presence of these joints might have permitted the analysis of the arches as approximately three-hinged structures, but this was not actually done.) The arch conduits when constructed were singularly free from cracks or other indications of distress in the concrete and this is believed to have been largely due to the presence of the radial joints.

As the preceding indicates, the conduits were designed not as rigid boxes but as arches on separate abutments. The wall load therefore is carried directly by the wall footings and the pavement between them supports no load except that of the water.

Rich Concrete Surfacing.—It was specified in the original plans for the conduit construction that a rich interior facing should be applied to the inside of the conduits as wear-resistant lining. This was to be made of 1:1½:3 mixture using a specially selected crushed granite as coarse aggregate. It was foreseen in the structural design of the conduits that this lining might perhaps be applied as a separate course from the body of the conduit concrete, so that the thicknesses shown by the drawings are in all cases 3 in. more than the structural calculations demanded.

River gravel taken directly from the Miami Valley was shown by test to make a concrete fully equal and in some tests superior to that made with crushed granite brought from a distance. It was then decided to use for the wear-resistant lining the same gravel that served for making the body concrete, but to change the mixture to 1:1½:3 (in place of 1:2:4) by adding a bag of cement per batch when mixing concrete intended

for the face portion. Further, in the thick parts of the work, as in the lower part of the walls, two mixtures are used, being placed simultaneously and separated only by their being deposited against the face form or farther back in the section; but for the thinner parts, as the arches, the rich (1 : 1½ : 3) mixture is used for the whole thickness, as this is cheaper than trying to gain a little cement at the cost of separating two mixtures in a thin wall. This integral rich-mixture construction is used for the arch and the thin upper part of the conduit wall, and the separation is used only in the more massive lower parts of the wall.

Somewhat similar remarks apply to the retaining-wall work and the jump-pool lining, in which the face is composed of a 1:2:4 mixture and the body of 1:3:6. The richer lining layer is generally 1 ft. thick.

Special Design of Concrete Bridges

In the design of bridges required in connection with the Taylorsville and Huffman basin construction, conditions were encountered that led to several original details. Three-hinged reinforced-concrete arches were built at two of the locations, the adoption of hinging being due to the desire to avoid large stresses in the concrete due to settlement and temperature effects; the hinges also have interesting details. An electric railway viaduct crossing through the Huffman basin was designed with continuous concrete girders.

In planning a crossing over the relocated line of the Cincinnati, Hamilton & Dayton R.R. at the west end of the Taylorsville dam it was desired to use a concrete span for appearance and to give low maintenance cost. It is expected that this line may at some time be four-tracked, and in order to span the future roadbed width and the embankment slope a span length of nearly 100 ft. became necessary. The length was considered to eliminate a girder design and demand an arch.

As the foundation material was earth, and compression or settlement might occur, a monolithic arch ring might be subject to cracking. On this account and to avoid high temperature stresses the three-hinged arch type was adopted. Its application to the case is shown in the accompanying outline drawing Fig. 7, which illustrates a second bridge of the same kind, but skewed in plan, subsequently built at the Huffman dam.

Normal bridge design methods were used in working out the main elements of the structure. The hinge details are special; they are shown separately in Fig. 7.

A manganese-bronze pin forms the hinge of the joint. This is 1½ x 20 in. in the case of the Taylorsville arch, and 2¼ x 28 in. in the case of the Huffman arch. The seats for the pin are formed by manganese bronze journal blocks, resting in a cast-iron pressure-distributing shoe (cast steel in the case of the Huffman bridge, with base 28 x 38 in.). Each half of the hinge is completely encased in concrete to within ½ in. of the center line of the joint, leaving a ½-in. open joint in the concrete.

The Taylorsville arch rib was shaped in accordance with the stress requirements due to the variation in position of the pressure line, so that it has its greatest depth at the haunches. The Huffman arch was modified by shaping the rib at its outer face to an outline increasing in depth from crown to springing (this is not shown in Fig. 7). Only the outer face of the rib is carried to this shape, however, the main body of the rib being made to the outline required by the pressure lines.

At a crossing of the Ohio Electric Ry. through the upper part of the Huffman basin, requiring a bridge over the Mad River, the waterway was increased for flood-flow purposes by adding to the bridge two lengths of reinforced-concrete trestle. These trestles consist of 30-ft. simple reinforced-concrete girder spans carried by two-pedestal piers on a single foundation slab. There is an expansion joint at both ends of each span. At one point, however, where several skew spans became

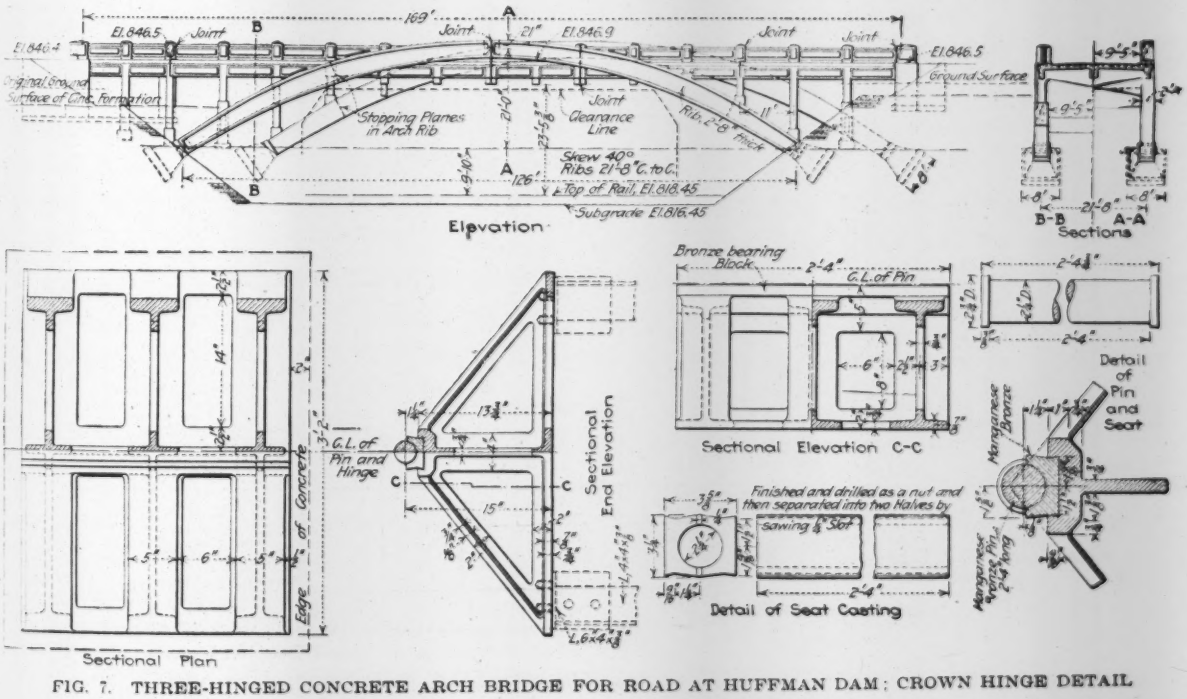


FIG. 7. THREE-HINGED CONCRETE ARCH BRIDGE FOR ROAD AT HUFFMAN DAM: CROWN HINGE DETAIL

necessary, the distance between centers of supports was lengthened to 36 ft., and here, to retain the same depth of girder, three consecutive spans were made continuous over the piers. The arrangement is shown by a small-scale sketch in Fig. 8, and requires no further explanation. The reinforcing steel is unusual in the method of end anchorage used, as shown.

Longitudinal forces of rather large amount act at the tops of the piers, arising from sliding on the expansion bearings due to temperature change, or from braking thrust of cars. The two-pedestal pier is depended upon for longitudinal stability.

Remarkably heavy loading was specified (by the Ohio Electric Ry.) for these structures. Each track is required to carry two 100-ton cars coupled, and the roadway has a 12-in. thickness of ballast. This loading is equivalent to 6,000 lb. per lineal foot of track, or 50,000-lb. axle concentrations. Traffic of this weight is not running on the railway at present.

The general types of structures, the standard dam section and similar features of the designs described in the preceding article were worked out under the direction of Arthur E. Morgan, chief engineer of the district. Charles H. Paul, assistant chief engineer, had supervision over the preparation of contract plans and specifications and the detail designs of structures. S. M. Woodward, consulting engineer, directed the hydraulic computations and assisted on many features of the designing. Walter M. Smith, designing engineer, had direct charge of all designs, giving special attention to the arch design for the conduits, and the forms and centering. He was assisted by Ross M. Riegel, assistant designing engineer, who dealt chiefly with the combined conduits and spillways and the arch bridges.

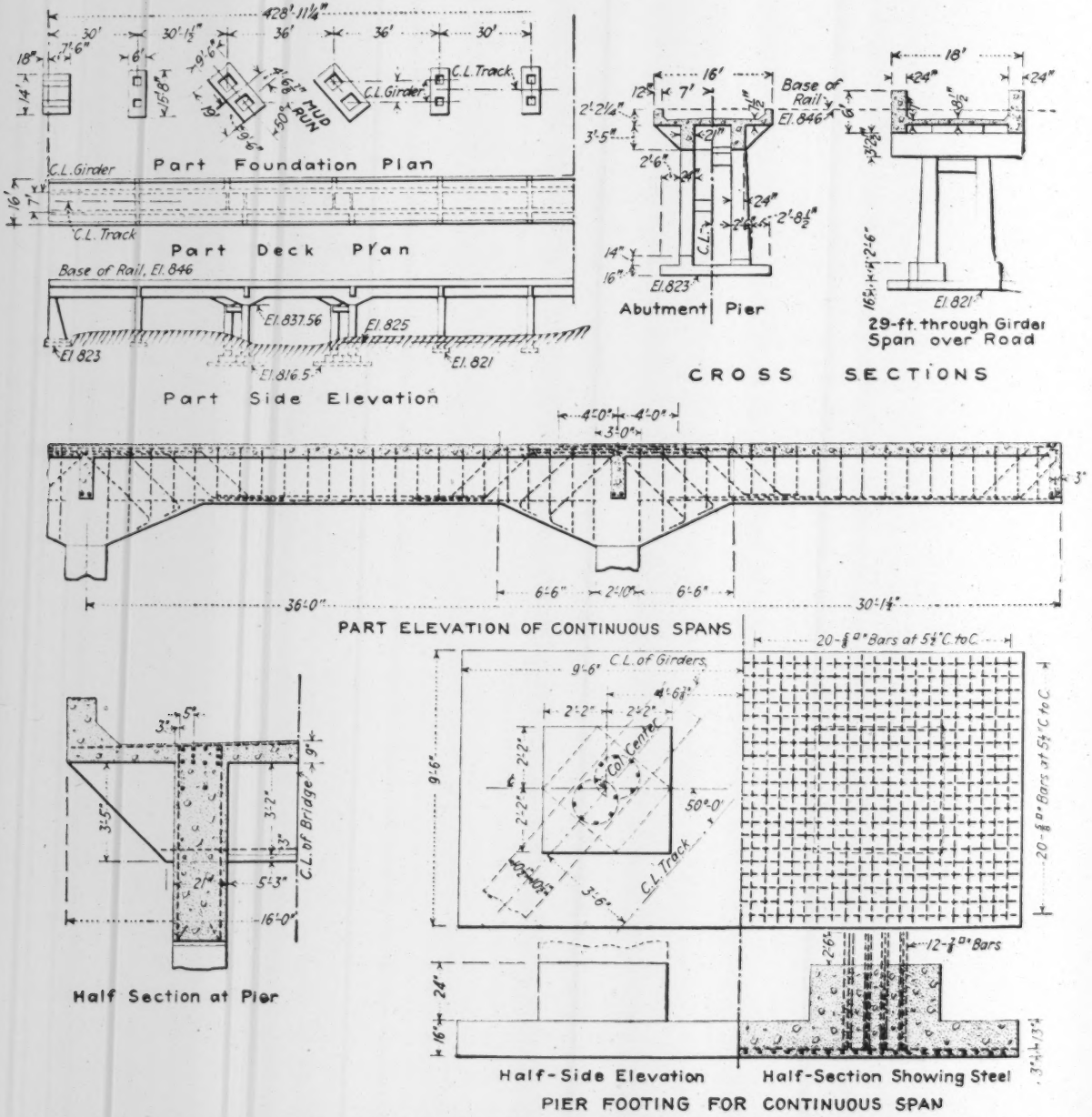


FIG. 8. CONTINUOUS GIRDER SPANS AND SLAB FOOTING OF PIER, MUD RUN BRIDGE

War Department Would Study Waterway Economics

AN outline of a new Federal inland waterway policy is contained in a statement of the Secretary of War in connection with the recent hearing on the Wadsworth resolution returning the New York State Barge Canal to the State of New York. It is evident from this that the War Department is willing, even anxious, to take control of the national study of waterway transportation. Extracts from the statement are as follows:

Students of inland waterway transportation, of whom there are many in, as well as outside, the War Department, have long been advocating the necessity for the establishment of a governmental agency qualified and authorized to make a comprehensive survey of the national waterway situation, more particularly from what might be called a practical operating point of view. National waterway development has in the past been greatly handicapped by the lack of such a comprehensive consideration of its purely traffic features, with the result that we are now forced to admit that many of the appropriations invested in localized waterway promotions have not paid anticipated dividends. Such expenditures have been not only a waste of public money, but at the same time have handicapped the development of those waterway projects which possess real merit; and to this end have acted as a deterrent to the healthy promotion of water-borne traffic as a whole. One of the sections of the Transportation Act provides an ideal means for filling this long-felt need. If the War Department is permitted to continue on the program on which it now is engaged, it seems certain that the constructive development of national waterway transportation will receive a necessary impetus which could be secured in no other manner.

It will be my endeavor, and I have already directed definite steps toward that end, to prepare for the consideration of Congress accurate and disinterested data with regard to the traffic possibilities of various waterways, with particular regard to their utilization in connection with joint rail and water hauls, in a comprehensive manner which is in striking contrast to our previous largely sectional consideration of waterway transportation. Such data, when it is available, will be of inestimable value in connection with the intelligent consideration of future proposed waterway appropriations, and will also go far toward clarifying the present uncertainty as to the extent of profitable utilization of existing waterways.

This, though important, is but one phase of our undertaking. In my interpretation, the Transportation Act charges the War Department with not only analyzing the traffic possibilities of existing waterways, but also with determining and demonstrating the most economical methods for their utilization. The converging of these two distinct lines of endeavor will result, I am sure, in a much more intensive utilization of the waterway as a common carrier in the future than has been the case in the past, with a proportionate reduction in general transportation costs and relief of the railroads from some of the overwhelming burdens which they are today facing.

It is the latter phase of the operative development of waterway transportation, a phase equally if not more important than the work of furthering the utilization of existing equipment and waterways, which the resolution now under consideration particularly effects. To enable the practical execution of this work, Congress has seen fit to turn over to the War Department the floating equipment acquired by the U. S. Railroad Administration for its waterway operations. It is my construction that these barges should be operated by the War Department from altogether different motives than they were by the Railroad Administration. The latter organization, having a number of waterways on which it wished to operate, but lacking sufficient floating equipment for their efficient utilization, contracted for the necessary barges and used such of them as it secured for the primary purpose of relieving the acute railroad congestion which we faced during the war. The War Department, on the other hand, is merely accepting this equipment which the government already owns, in lieu of the purchase of new equipment which otherwise would be necessary in the execution of its new duties in developing types of equipment and demonstrating the nature of services essential to successful waterway operation.

While it is true that the New York Barge Canal operations of the War Department could be abandoned without frustrating our plans, however, the sale to private interests of the equipment with which these operations are being conducted would seriously handicap our entire waterways program at this time.

Incidentally, it may not be irrelevant to point out that this floating equipment on the New York canal exists only through the initiative of the Federal Government and was constructed because private capital had failed to provide the canal with the barges found to be necessary for its effective utilization during the war. When this construction was undertaken by the government it was considered advisable to incorporate in the designs of these new barges certain features never before attempted in this country, particularly with regard to the introduction of a type of barge capable of carrying its own cargo and at the same time serving as a propellant for other barges, thus offsetting the dead expense of tow boats. This and similar practicable improvements in barge construction the government is attempting to develop for the benefit of waterways generally, but it is hoped to demonstrate the economic features of waterway operation, not alone through the development of more suitable floating equipment, but also through the utilization of such improved equipment on a large scale and in maximum quantities, a proposition which is believed to be essential for the most efficient waterway utilization, but one which has not heretofore been, and which probably will not now, be taken up by private capital unless its feasibility is practically demonstrated by the government. This is one subject which we are particularly anxious to accomplish, but the passage of this resolution will counteract materially our efforts in this direction, in that it will probably have the effect of splitting up those boats among a number of small operators, while it is believed that the maximum of economy in waterway transportation can be obtained only through the organization of large and heavily capitalized operating companies.

Water-Power Development in Canada

The Dominion Water Power branch of the Canadian Department of the Interior, and the Dominion Bureau of Statistics have completed a census of the development of water power, according to which there is installed throughout Canada some 2,418,000 turbine or water wheel hp. of which 2,215,000 is regularly employed. Of the total power installed 1,756,791 hp. or 72.7% is in central electric stations, i.e. where power is developed for sale and distribution. In the pulp and paper industry 473,265 hp. is utilized of which 381,631 hp. is generated directly from water in pulp and paper establishments, while 91,634 hp. is purchased from hydro central electric stations. Hydro power used for other purposes is listed as follows: for lighting 434,613 hp.; in mining industry, 177,728 hp.; in flour and grist mills, 42,736 hp.; in lumber and saw mills, 37,918 hp.; and in other manufacturing industries, 172,955 hp. The total installation is comprised of 3,370 units of an average capacity of 715 hp. The figures of 70 representative hydro-electric stations with an aggregate turbine installation of 745,797 hp. show a total construction cost of $50,740,468 or an average of $69.11 installed hp.

Factors Affecting the Use of Water in Irrigation

Experimental and Practical Aspects Discussed in Conjunction with Presentation of Data on Water Use Collected from 22 U. S. Reclamation Service Projects

By E. A. Moritz
Office Engineer, U. S. Reclamation Service, Denver, Colorado

A DETERMINATION of the amount of water used by irrigation projects and its relation to the quantity scientifically and practically needed has been for years the favorite topic for debate at all gatherings of irrigation engineers. However, we still seem far from a satisfactory solution of the question. The present discussion takes up the scientific and practical aspects of the subject in conjunction with data in regard to the disposition of the water used on 22 projects of the U. S. Reclamation Service. There is shown how much water is delivered to the land, what portion is lost by seepage and how the quantity used varies during the several months of the year. The water requirements of irrigation depend upon such a multitude of varying factors that a separate analysis is usually considered necessary in each case, based upon experiment and experience obtained under similar conditions. Acceptance of this dictum as an answer to the question of quantity would not lead to a solution of the problem as it is obviously impossible to duplicate any given set of conditions. Irrigation is a growing industry. In a large sense it is yet in its infancy in this country. It is not surprising, therefore, that accurate knowledge in all its phases is not at hand. Development will come with growth, and time is required to bring the facts to light. The early irrigators had troubles enough without bothering to measure the quantities of water they used except in a relative fashion. Consequently, until comparatively recently, since irrigation farming has become an industry handled on a large scale by business organizations, no accurate records were kept and we were compelled to grope along with little more guidance on the subject of water requirements than the early irregators had. Now the situation is much better as a result of the many scientific investigations that have been made and the practical experience data that has been recorded but there is still much obscurity and the object of this article is to throw an increment of additional light on the subject.

What is the maximum area which a given water supply will irrigate? Early answer must be given to the financial interests and laid down as the basis for designs. The engineer is compelled to make assumptions based on past experience. The better and more complete the experience the more nearly will estimates be realized. Feeling that a new era of irrigation development is nearly upon us, and that engineers should have the benefit of the widest available information which the U. S. Reclamation Service afforded, Mr. Moritz was asked to collect operating information from 22 projects representing almost every condition to be met with in the semi-arid part of the country. His preliminary discussion makes apparent the significance and importance of the statistical data.—Editor.

Although, as stated there are a multitude of varying factors that influence the quantity of water required to raise crops by irrigation, most of them can in the course of time be brought under control to a greater or less extent or will automatically adjust themselves to the natural requirements of the particular project in hand and there remain only three fundamental factors upon a consideration of which the probable water requirements must be based. These are the soil, the climate, and the class of crops.

It may be stated at the outset that no exact or accurate prediction can be made of the effect, either actual or relative, of each of these factors on the water requirements but knowledge of the class of crops is fundamental in the design of an irrigation project and the irrigation engineer is compelled to make an analysis of the situation and arrive at definite figures on the basis of such information as is available, coupled with judgment and experience.

Where all other conditions are equal there are porous soils that apparently require two or three times as much water for successful farming as more impervious soils; that is, where 2 acre feet per acre are required for the tight soils, 4 or 6 acre feet are apparently needed for the more open soils. The quantity of water usefully consumed by the plants is undoubtedly the same in each case, the excess water being lost by deep percolation into the substratum. The figures used in the foregoing illustration are quite common; in rarer instances the quantity of water applied to porous soils might be very much greater. Such great variations do not occur when whole projects are considered but the condition described obtains only in comparison between farms or, at most, districts of a project, although on the Umatilla Project in Oregon and the Boise and Minidoka projects in Idaho areas of several thousand acres apparently require markedly larger quantities of water than other parts of the project. On the first two projects it has been found necessary to eliminate several thousand acres from the project because of the excessive quantities of water needed to raise crops on the very porous soils.

Opinions differ as to whether an excessive use of water on porous soils is necessary. Certainly if it is necessary then the proper thing to do is to refrain from attempting to crop such land, especially if water is not plentiful. Moreover, the places are few where excessive use of water can be practiced very long without water logging adjacent or lower lying lands, thus making necessary the construction of drainage works. Much of the drainage of irrigated land that is now necessary could have been obviated by the more careful and sparing application of irrigation water, but it is very difficult to impress this fact upon irrigators in time to prevent the damage.

Climate determines the length of the growing season. Longer seasons permit greater crop production, and a corresponding increase in the water requirements of the crops results. Rainfall, especially during the irrigation season, is an important item, although usually not as valuable as an equal quantity of water

applied artificially because it may not come at the right time and in the case of a light rainfall a large percentage of it may not reach the plant roots while in the case of a heavy rainfall of short duration surface runoff may dispose of a large percentage. In a warm climate with a high wind movement evaporation undoubtedly disposes of a considerable proportion of the water. Nearly all irrigated regions are subjected to hot winds occasionally, and it has been found by experience in some cases to be almost impossibly to supply enough water to the fields to overcome the evil effects of a prolonged hot wind.

Class of Crops

All crops do not need the same quantity of water. With similar conditions of soil and climate where grains require 15 to 18 in. of water, root crops, such as potatoes and sugar beets, require 18 to 24 in. and alfalfa requires 24 to 30 in. The water requirements of orchards are not so well known but they probably fall somewhere between grain and root crops.

Under identical conditions one man uses 2 acre feet per acre while another uses 4 acre feet per acre to raise a crop of alfalfa, both apparently obtaining about the same results as to yield and quality of product. It has been quite conclusively demonstrated that the total yield will continue to increase with additional application of water but the yield per unit of water decreases with the additional water used. Thus Widtsoe (John A. Widstoe: Paper presented before the Second Pan-American Scientific Congress, Washington, D. C., Dec. 27, 1915) cites a yield of alfalfa of 9.12 tons per acre with 30 in. of water and a yield of 9.19 tons per acre under identical conditions with 60 in. of water, the yield per acre inch in the first case being practically double that in the second case.

At the inception of a project it cannot be predicted what crops will be raised and this cannot be controlled by the designer nor by the manager of the completed project. However, some information is always available in regard to the crops that will probably predominate. For example, on most larger projects, taken collectively, forage crops constitute about one-half the cropped area. In the prairie states grains will make up most of the remainder and where sugar beets, fruit or cotton are grown the percentages are about 50 per cent forage crops, 25 per cent grain and 25 per cent fruit, sugar beets, or cotton. The uncertainty is therefore not as great as it might at first appear and the larger the project the less the uncertainty as to the class of crops that will be raised because a diversity of crops is necessary for the success of the project.

The information available on the quantity of water required to grow crops is derived from two main sources: (1) scientific experiments made on small tracts of land on which a single crop was grown and accurate measurement made of the quantity of water used; (2) records of results of practical operations of irrigation systems. To the engineer charged with the design of an irrigation system the latter is by far the more important and useful source of information. The former has an important supplemental value.

These have been made principally by the U. S. Department of Agriculture and the various State Experiment Stations. Typical of the results so obtained are those of the Utah Experiment Station at Logan, Utah, a partial summary of which is given in the following table*:

TABLE I. ACRE YIELDS OF CROPS WITH VARYING QUANTITIES OF WATER
(Rainfall and soil water = 13.74 in.)

Water applied, in.	Wheat Bu.	Corn Bu.	Sugar Beets Tons	Potatoes Bu.	Alfalfa Tons
5.0	37.8		13.8	154	
7.5	41.5	79.1		182	
10.0	43.5	89.5	18.6	195	4.0
15.0	45.7	93.9	19.5	227	3.8
20.0		91.6	21.3	267	4.5
25.0	46.5	99.2			4.6
30.0		97.1	20.8	244	4.4
35.0	48.5				
40.0				250	
50.0	49.4		24.5		5.4
55.0		96.8			
60.0				304	

* John A. Widtsoe—Paper before Second Pan-American Scientific Congress, Washington, D. C., December 27, 1915.

The above results are substantially confirmed by other experiments. They show that in general the yield of a crop is increased with the application of additional water but not in proportion to the quantity of water applied. From the data available Widtsoe expresses his conclusion in the following form, which he calls the first law of irrigation: "The crop producing power of each unit of irrigation water diminishes as the total quantity of water used is increased."

Table I shows that the greatest yields per acre are obtained with quantities of water that even the most lavish users of water would consider excessive. Much of the water so used is wasted because the crops have not the power to limit the quantity of water that they can economically use but, as Widtsoe says, the excess water is merely carried through the plant as through a pumping system and wasted by transpiration into the air. This fact lies at the bottom of and is the cause of the great disagreement between irrigators and irrigationists as to the quantity of water *needed* by crops. This is also why, fundamentally, scientific data are a valuable supplement to the results of practical operations, which latter record experience only without regard to the fundamental principles and requirements involved.

Since there appears to be no reasonable limit to the quantity of water that a plant can tolerate so long as the ground is not actually saturated, irrigators are inclined to use a quantity limited only by the supply available or the cost of applying it to the land, even though such lavish use of water injures the land, and, in fact, the quality of the crop also. The truth of this has been demonstrated in practically all irrigated districts where history and statistics will show that at first, when small areas only were irrigated and water was plentiful, much water was used, whereas, as time went on and water became more scarce its use was adjusted to the supply available with just as good and perhaps better results as to crop yield, and infinitely better results as to the economical development of the community.

The difficulty in measuring the large quantities of water used for irrigation, and the apparent high cost of doing so has been a deterring factor in the accumulation of accurate data on the quantity of water used by irrigators. The reasonableness of the cost of obtaining a given result is measured by the value of the result obtained. When water is plentiful it does not pay to spend large sums of money in measuring it out; or, in other words, the value of the commodity does not warrant its careful measurement. Generally, this prin-

ciple has been recognized and acted upon on all projects at their inception and consequently no adequate provision was made for water measurement. When water became scarce and the need arose for measuring it carefully, it was in many cases very difficult to install devices that would give accurate results. Consequently, even now on projects where water is very valuable and all water is measured out, the quantities used are frequently in doubt because of the crude nature of the measuring devices.

The projects of the U. S. Reclamation Service do not differ from other irrigation enterprises in their lavish use of water, especially during the early stages of development. Moreover, few of the projects have passed this stage. Statistics have, however, been kept of the quantities of water used, crops grown and related data and these form a very important source of information for the use of the irrigation engineer.

Table II shows the average results of operation of 22 government projects for the seven irrigation seasons 1912 to 1918, inclusive. It also shows the maximum and minimum quantities of water used per season during that period. On most of the projects much improvement is possible in the use of water and the figures shown do not necessarily indicate that so much water is needed to raise crops. The abundance of water available in most cases has made economy unnecessary. A careful investigation into the accuracy of these figures has developed that they are probably correct within 5 to 20 per cent. Not all the figures are of equal accuracy: Class A represents an accuracy of 5 per cent or less; Class B, 5 to 10 per cent; Class C 10 to 15 per cent and Class D 15 to 20 per cent.

The possibility of reducing the quantities of water used on these projects is indefinite, but like all irrigation development in the past there will no doubt be a slow evolution from present wasteful use to a more and more economical use as more lands are brought under irrigation and water becomes less plentiful and consequently more valuable. Only time can bring this matter to its ultimate solution. Threats of injury to lands and prospects of heavy costs for drainage, and financial deterrants such as charging high rates for excessive quantities of water do not seem to have the desired effect in holding down the use of water to minimum or even reasonable requirements. The ultimate solution appears to lie solely in the operations of a physical deterrant in the form of limited available water supply so that it will not be possible to use too much water because the water is not there to use. This condition has been reached in parts of Colorado and California with the result that now only from one-half to one-third as much water as formerly is used.

What can be accomplished under force of circumstances has been well demonstrated on the Orland project. The average use of water on that project during the six years 1912 to 1917 was 3.66 acre-feet per acre. In 1918 the water supply was much less than usual, and it was possible to deliver only 1.91 acre-feet per acre. In his annual report the project manager states: "Due to the limited water supply it is estimated that there was a loss of 20 per cent in the alfalfa crop, although there was ample water for all other crops." Alfalfa comprised about one-third the cropped area, so that the crop loss over the whole irrigated area amounted to only about 7 per cent with a water supply of only 52 per cent of the usual supply. The rainfall during the irrigation season was also less than the average. Including rainfall the average water supply in the years 1912 to 1917 was 4.01 acre-feet per acre and in 1918 it was 2.21 acre-feet per acre or 55 per cent. This shortage in the water supply came on unexpectedly, and the farmers were not trained to get along with such a small supply, hence there was some crop damage, but it is not unlikely that if such a limited water supply became habitual the Orland project would get along very nicely on 2 acre-feet per acre of water instead of the nealy 4 acre-feet now used.

TABLE II. TOTAL QUANTITIES OF WATER DELIVERED AT THE LAND, CROPS GROWN AND OTHER DATA, YEARS 1912 TO 1918, INCLUSIVE. GOVERNMENT PROJECTS

Project	Acre Feet per Acre Delivered at the Land Including Precipitation during Irrig. Season			Precipitation During Irrig. Season	Temperature During Irrig. Season	Percentage of Cropped Area in Different Classes of Crops					Relative Accuracy of Figures in Columns 2, 3 and 4
	Max.	Min.	Mean	Mean	Mean	Cereals	Forage	Orchard	Vegetable	Miscellaneous	
1	2	3	4	5	6	7	8	9	10	11	Class
Salt River, Ariz.	4 24	3 11	3 64	0 69	69	19	64	2	3	12	C
Yuma, Ariz.	4 85	3 40	3 96	0 22	73	32	44	0	2	22	C
Orland, Cal.	4 55	2 21	3 76	0 34	70	9	86	3	2	0	B
Uncompahgre, Colo.	7 02	5 40	6 14	0 59	60	33	42	6	14	5	B
Boise, Idaho	4 35	2 73	3 47	0 60	61	48	47	1	3	1	A
Minidoka, Idaho:											
No. Side Gravity	6 71	3 95	5 46	0 53	59	25	63	1	6	5	B
So. Side Pumping	3 45	2 87	3 23	0 53	59	39	45	0	9	7	A
Huntley, Mont.	2 40	1 46	1 97	0 73	63	36	37	0	2	25	C
Milk River, Mont.	1 84	1 20	1 51	0 70	57	48	51	0	1	0	D
Sun River, Mont.	2 35	1 94	2 18	0 73	59	43	54	0	3	0	B
Lr. Yellowstone, Mont.	2 53	1 83	2 21	0 83	62	56	41	0	2	1	D
No. Platte, Neb.	3 56	2 72	3 17	0 94	63	36	50	0	5	9	B
Newlands, Nev.	3 99	2 67	3 36	0 27	59	11	86	0	2	1	B
Carlsbad, N. M.	4 08	2 61	3 43	1 01	66	29	52	1	0	18	C
Rio Grande, Tex.	8 92	4 75	6 82	0 63	67	25	62	2	5	6	C
Umatilla, Ore.	8 73	5 56	6 98	0 33	62	3	84	7	4	2	A
Klamath, Ore.	1 74	1 13	1 48	0 33	60	36	61	0	2	1	B
Belle Fourche, S. D.	2 22	1 42	1 92	0 87	64	49	47	0	1	3	B
Okanogan, Wash.	3 07	1 41	2 38	0 41	63	5	36	51	7	1	A
Yakima, Wash.:											
Sunnyside Unit	3 67	2 70	3 37	0 28	62	13	56	19	9	3	A
Tieton Unit	2 55	2 07	2 38	0 19	64	22	44	13	19	2	A
Shoshone, Wyo.	2 86	2 16	2 61	0 48	57	41	55	0	2	2	B

NOTE—On the Rio Grande project from 1912 to 1917, all water was delivered at lateral and community ditches; in 1918, about 15% of the total was delivered at the land.

Alfalfa the Backbone of Irrigation

Table II contains interesting information of the classification of crops raised. It is probably not generally known or realized that alfalfa constitutes the greater part of the crop on nearly all irrigation projects, and that such special crops as fruit, cotton and sugar beets constitute relatively small percentages of the crop even when these special crops are supposed to be grown on a large scale. For example, the Salt River project has quite a reputation for cotton production but only 24 per cent of the area was devoted to cotton in 1918 while 53 per cent was devoted to forage crops. Also the Yakima project is in the heart of a fruit growing district but on the Sunnyside unit only 17 per cent of the area was devoted to fruit in 1918 while 54 per cent was devoted to forage crops and on the Tieton unit the percentages were 27 and 43 respectively. Combining all the projects the percentage of area devoted to forage crops, mostly alfalfa, is 56, which demonstrates in a broad way that alfalfa is the backbone of irrigation agriculture and that other crops are more or less incidental.

For purposes of design of the principal canals and structures and determination of storage requirements, a knowledge of the quantity of water required each month is of prime importance.

TABLE III. MONTHLY USE OF IRRIGATION WATER DELIVERED AT THE LAND YEARS 1912 TO 1918, INCLUSIVE. GOVERNMENT PROJECTS

Project		Acre-Feet per Acre Delivered at the Land (Precipitation not included)											
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Salt River Project Arizona	Max.	0 25	0 33	0 32	0 37	0 49	0 50	0 37	0 37	0 47	0 28	0 19	0 11
	Min.	0 01	0 02	0 19	0 25	0 32	0 21	0 21	0 28	0 21	0 16	0 09	0 03
	Av.	0 08	0 13	0 26	0 31	0 38	0 38	0 35	0 33	0 34	0 20	0 14	0 07
	Av. %	2 7	4 4	8 7	10 5	12 8	12 8	11 8	11 1	11 4	6 7	4 7	2 4
Yuma Project Arizona	Max.	0 20	0 41	0 40	0 42	0 44	0 53	0 61	0 62	0 51	0 34	0 22	0 21
	Min.	0 05	0 03	0 28	0 31	0 27	0 40	0 39	0 42	0 36	0 22	0 04	0 03
	Av.	0 10	0 18	0 35	0 36	0 37	0 45	0 48	0 50	0 44	0 27	0 13	0 11
	Av. %	2 7	4 8	9 4	9 6	9 9	12 0	12 8	13 4	11 8	7 2	3 5	2 9
Orland California	Max.		0 06	0 31	0 53	0 79	0 81	0 80	0 78	0 67	0 30	....	....
	Min.		0 00	0 00	0 01	0 21	0 37	0 33	0 24	0 00	0 00	....	....
	Av.		0 01	0 07	0 28	0 59	0 67	0 68	0 59	0 40	0 12	....	....
	Av. %		0 3	2 1	8 2	17 3	19 6	20 0	17 3	11 7	3 5	....	....
Uncompahgre Valley Colorado	Max.				0 43	1 32	1 34	1 35	1 11	0 72	0 50	....	....
	Min.				0 00	0 72	1 02	0 83	0 85	0 58	0 33	....	....
	Av.				0 20	0 97	1 17	1 11	0 97	0 71	0 42	....	....
	Av. %				3 6	17 5	21 0	20 0	17 5	12 8	7 6	....	....
Boise Idaho	Max.				0 37	0 86	0 83	0 90	0 65	0 47	0 07	....	....
	Min.				0 00	0 19	0 55	0 54	0 26	0 12	0 02	....	....
	Av.				0 16	0 52	0 69	0 71	0 48	0 27	0 04	....	....
	Av. %				5 6	18 1	24 0	24 7	16 7	9 4	1 5	....	....
Minidoka (No. Side Gravity) Idaho	Max.				0 44	1 24	1 36	1 53	1 38	0 82	0 18	....	....
	Min.				0 00	0 36	0 89	0 97	0 87	0 35	0 00	....	....
	Av.				0 17	0 78	1 08	1 20	1 06	0 58	0 06	....	....
	Av. %				3 5	15 8	21 9	24 3	21 5	11 8	1 2	....	....
Minidoka (So. Side Pump.) Idaho	Max.				0 25	0 55	0 79	0 90	0 79	0 43	0 05	....	....
	Min.				0 00	0 10	0 43	0 68	0 37	0 25	0 00	....	....
	Av.				0 04	0 32	0 59	0 77	0 61	0 35	0 02	....	....
	Av. %				1 5	11 8	21 9	28 5	22 6	13 0	0 7	....	....
Huntley Montana	Max.				0 03	0 16	0 40	0 64	0 57	0 11		....	....
	Min.				0 00	0 00	0 01	0 26	0 28	0 05		....	....
	Av.				0 00	0 06	0 23	0 46	0 40	0 09		....	....
	Av. %				0 00	4 8	18 5	37 1	32 3	7 3		....	....
Milk River Montana	Max.				0 14	0 40	0 34	0 62	0 12	0 05	0 06	0 03	....
	Min.				0 00	0 00	0 00	0 16	0 00	0 00	0 00	0 00	....
	Av.				0 04	0 16	0 14	0 34	0 06	0 02	0 04	0 00	....
	Av. %				5 0	20 0	17 5	42 5	7 5	2 5	5 0	0 0	....
Sun River Montana	Max.					0 54	0 80	0 93	0 58	0 18	0 01	....	....
	Min.					0 00	0 15	0 06	0 18	0 01	0 00	....	....
	Av.					0 14	0 41	0 50	0 32	0 07	0 00	....	....
	Av. %					9 7	28 5	34 7	22 2	4 9	0 0	....	....
Lower Yellowstone Montana	Max.					0 20	0 71	0 98	0 48	0 11	0 06	....	....
	Min.					0 00	0 08	0 46	0 06	0 00	0 00	....	....
	Av.					0 04	0 37	0 68	0 23	0 05	0 01	....	....
	Av. %					2 9	26 8	49 3	16 7	3 6	0 7	....	....
North Platte Nebraska-Wyoming	Max.					0 31	0 75	0 72	0 80	0 47	0 02	....	....
	Min.					0 01	0 25	0 56	0 23	0 22	0 00	....	....
	Av.					0 16	0 49	0 65	0 57	0 37	0 00	....	....
	Av.					7 1	21 9	29 0	25 5	16 5	0 0	....	....
Newlands Nevada	Max.			0 26	0 73	0 96	0 68	0 75	0 49	0 32	0 16	0 04	....
	Min.			0 01	0 21	0 43	0 39	0 18	0 15	0 22	0 01	0 00	....
	Av.			0 08	0 41	0 66	0 61	0 57	0 40	0 27	0 09	0 01	....
	Av. %			2 6	13 2	21 3	19 7	18 4	12 9	8 7	2 9	0 3	....
Carlsbad New Mexico	Max.	0 03	0 15	0 22	0 52	0 51	0 58	0 50	0 62	0 38	0 19	0 11	....
	Min.	0 00	0 00	0 00	0 06	0 32	0 17	0 08	0 02	0 16	0 02	0 00	....
	Av.	0 01	0 05	0 10	0 42	0 40	0 36	0 33	0 38	0 23	0 09	0 06	....
	Av. %	0 4	2 1	4 1	17 3	16 5	14 8	13 6	15 6	9 5	3 7	2 4	....
Rio Grande New Mexico-Texas	Max.	0 17	0 47	0 83	0 91	1 04	1 18	1 13	0 80	1 05	0 68	0 29	0 40
	Min.	0 00	0 05	0 15	0 65	0 93	0 80	0 22	0 05	0 04	0 09	0 00	0 00
	Av.	0 03	0 26	0 61	0 82	0 98	1 03	0 81	0 63	0 59	0 28	0 07	0 09
	Av. %	0 5	4 2	9 8	13 2	15 8	16 6	13 1	10 2	9 5	4 5	1 1	1 5
Umatilla Oregon	Max.			0 21	1 09	1 59	1 71	1 78	1 63	1 10	0 26	0 05	....
	Min.			0 00	0 25	0 66	0 98	0 94	0 82	0 52	0 00	0 00	....
	Av.			0 04	0 76	1 15	1 36	1 29	1 28	0 71	0 06	0 01	....
	Av. %			6	11 4	17 3	20 4	19 4	19 2	10 7	0 9	0 1	....
Klamath Oregon	Max.				0 02	0 38	0 47	0 42	0 26	0 06	....	....	....
	Min.				0 00	0 00	0 29	0 14	0 16	0 03	....	....	....
	Av.				0 01	0 21	0 38	0 29	0 22	0 04	....	....	....
	Av. %				0 9	18 3	33 0	25 2	19 1	3 5	....	....	....
Belle Fourche So. Dakota	Max.					0 03	0 68	0 69	0 30	0 14	0 02	....	....
	Min.					0 00	0 02	0 10	0 03	0 07	0 00	....	....
	Av.					0 01	0 33	0 41	0 19	0 11	0 00	....	....
	Av. %					0 1	31 4	39 0	18 1	1 04	0 0	....	....
Okanogan Washington	Max.				0 02	0 55	0 66	0 81	0 77	0 37	0 03	0 04	....
	Min.				0 00	0 06	0 30	0 16	0 10	0 00	0 00	0 00	....
	Av.				0 00	0 25	0 49	0 52	0 57	0 12	0 01	0 01	....
	Av. %				0 00	12 7	24 9	26 4	28 9	6 1	0 5	0 5	....
Yakima Sunnyside Washington	Max.				0 34	0 60	0 59	0 65	0 63	0 44	0 27	....	....
	Min.				0 16	0 48	0 49	0 54	0 26	0 11	0 18	....	....
	Av.				0 28	0 54	0 54	0 60	0 55	0 36	0 22	....	....
	Av. %				9 1	17 5	17 5	19 4	17 8	11 6	7 1	....	....
Yakima Tieton Washington	Max.				0 04	0 47	0 56	0 57	0 57	0 38		....	....
	Min.				0 00	0 31	0 34	0 42	0 43	0 12		....	....
	Av.				0 01	0 43	0 47	0 51	0 50	0 27		....	....
	Av. %				0 5	19 6	21 5	23 3	22 8	12 3		....	....
Shoshone Wyoming	Max.				0 19	0 40	0 70	0 80	0 48	0 23	0 19	0 12	....
	Min.				0 00	0 08	0 34	0 48	0 27	0 10	0 01	0 00	....
	Av.				0 04	0 27	0 50	0 64	0 42	0 17	0 05	0 04	....
	Av. %				1 9	12 7	23 5	30 0	19 7	8 0	2 3	1 9	....

The quantity of water lost in transit on an irrigation project is enormous and in some cases appears to equal or even exceed the quantity delivered to the farms. Much thought has been spent in considering methods and means of preventing such losses but these efforts have on the whole been attended with only moderate success. Even on projects where a considerable percentage of the canals has been lined with concrete the losses from the remaining canals which were probably thought not to need lining so badly constitute a large percentage of the diversion.

Many methods other than lining with concrete, such as oiling, puddling, artificial silting and lining with wood, have been used with more or less satisfactory results but the present state of the art indicates that concrete lining is the most practicable and satisfactory method. It is very costly, especially the lining of old canals which have a greater cross section than is needed for the smoother concrete surface, but its results are certain and permanent, especially in the milder climates and for this reason lining with concrete is now recognized as the standard method of preventing seepage losses. Even concrete lining, however, does not prevent losses entirely.

Table IV shows the losses that occurred on some of the government projects in each of the seven years 1912 to 1918, inclusive. The small indicated loss on the Uncompahgre project is due to the fact that most of the canals on this project act as collecting channels for lost and waste water of canals higher up, this resulting in virtual compensation for losses by gains. The peculiar arrangement of this distribution system together with the nature of the soil is therefore favorable to conservation of the water supply as far as waste and seepage losses are concerned. The small loss on the Rio Grande project results from the fact that the losses shown are those occurring in a few trunk canals only. The practice on that project in the past has been to deliver water to community ditches and water measurements were not made by the project management beyond the diversion to these ditches. In 1918 some of the community ditches were operated by the project management and water measured at the farms. That is the cause of the large increase in the indicated seepage loss in 1918.

Excluding the Uncompahgre and Rio Grande projects, for the reasons stated in the preceding paragraph, the lowest mean loss, 24.3 per cent, was on the Tieton project, Washington and the highest, 53.2 per cent on the Carlsbad project, New Mexico. The average loss for all the projects, exclusive of Uncompahgre and Rio Grande, is 36.1 per cent. It is difficult to explain the large variation in the losses on the basis of inherent differences in the plan of the distribution system or the differences in the material in which the canals are built. The latter is undoubtedly the most important factor and it is reasonable to suppose that a project having a long main canal and scattered lateral system will have relatively greater losses than one having a short main canal and a compact lateral system.

The Tieton project shows the smallest losses. The explanation for this probably lies in the fact that the main canal is a concrete channel for the first 12 miles of its length and most of the remainder occupies a natural drainage channel in impervious material. Some of the laterals also occupy natural drainage channels in similar material. The distribution system is very compact and pipes and flumes were freely used for the conveyance of water. The Orland project also shows a very low loss, which is no doubt due to the

TABLE IV. SEEPAGE LOSSES

Project	Total Losses—Per Cent 1912	1913	1914	1915	1916	1917	1918	Mean	Predominating Soils
Salt River	40.0	40.0	42.7	40.0	43.3	43.7	45.9	42.2	Sandy loam and clay.
Yuma	34.4	32.0	27.7	20.0	27.4	25.3	23.2	27.1	Rich alluvium.
Orland	20.0	26.5	26.0	27.3	20.5	27.3	33.1	25.8	Sandy loam, silt and gravelly loam.
Uncompahgre	4.8	5.1	7.6	12.4	2.2	2.9	7.7	6.1	Red sandy gravel, adobe and clay loam.
Boise	45.5	33.9	34.8	37.1	34.8	35.8	35.1	36.7	Clay loam and light sandy loam.
Minidoka:									
No. Side Gravity	28.0	22.6	25.0	36.3	43.9	48.9	41.4	35.2	Sandy loam, clay loam and volcanic ash.
So. Side Pumping	35.1	32.9	35.1	36.3	38.8	36.6	35.6	35.8	
Huntley	16.2	21.6	28.6	41.3	40.3	48.9	47.5	34.9	Clay and sandy loam.
Milk River	42.8	32.7	40.8	61.4	38.5	41.4	35.3	41.8	Sandy loam, clay and gumbo.
Sun River	20.0	38.1	39.7	41.8	41.9	37.6	40.3	37.1	Sandy loam, clay, adobe and alluvium.
Lower Yellowstone	43.0	52.0	52.4	43.1	47.9	42.8	46.9	46.9	Sandy loam, gumbo.
North Platte	38.7	38.4	36.8	66.0	40.7	47.2	37.7	43.6	Sandy loam.
Newlands	39.8	36.7	29.9	41.2	29.9	32.2	38.0	35.4	Sandy loam, clay and volcanic ash.
Carlsbad	48.0	54.5	55.5	48.6	58.5	57.2	50.1	53.2	Pecos sandy loam; large lime content.
Rio Grande		6.8	2.7	5.1	6.5	3.7	14.9	6.6	Rich alluvium.
Umatilla	27.8	27.4	40.1	43.8	36.5	24.8	32.2	33.2	Sandy loam.
Klamath	36.1	39.8	40.1	50.3	49.1	41.5	40.4	42.5	Disintegrated basalt, volcanic ash.
Belle Fourche	31.7	40.2	43.6	31.1	15.7	31.5	32.6	32.3	Clay and sandy loam.
Okanogan	47.1	38.4	21.1	24.1	22.2	20.4	33.7	29.6	Volcanic ash, sand and gravel.
Yakima Sunnyside	26.7	25.8	28.4	31.2	26.2	26.8	23.4	26.9	Sandy loam and volcanic ash.
Yakima Tieton	16.6	21.4	27.2	27.4	27.3	26.2	27.8	24.8	Volcanic ash.
Shoshone	36.4	36.5	37.2	35.1	34.9	41.8	37.7	37.1	Light sandy loam and clay loam.

TABLE V. DATA ON IRRIGATED AREAS OF 22 GOVERNMENT IRRIGATION PROJECTS LISTED IN TABLES II, III AND IV

Project	Area Irrigated—Acres 1912	1918	Mean Years 1912 to 1918, Inclusive
Salt River, Ariz	120,938	205,616	180,707
Yuma, Ariz	13,767	45,670	28,364
Orland, Cal	4,230	14,764	9,140
Uncompahgre, Colo	27,887	58,270	42,186
Boise, Idaho	65,042	131,500	95,950
Minidoka, Idaho:			
North Side Gravity	37,174	53,830	44,491
South Side Pumping	33,092	50,143	41,063
Huntley, Mont	14,425	18,958	17,481
Milk River, Mont	352	24,842	7,244
Sun River, Mont	6,824	7,569	6,437
Lower Yellowstone, Mont	5,068	21,075	10,567
North Platte, Neb	50,250	88,771	69,315
Newlands, Nev	36,620	42,311	38,506
Carlsbad, N. M	13,459	19,460	15,260
Rio Grande, Tex	23,115	64,781	43,771
Umatilla, Ore	4,600	9,100	5,990
Klamath, Ore	23,834	38,268	27,959
Belle Fourche, So. Dak	27,897	52,445	41,926
Okanogan, Wash	7,260	6,402	7,536
Yakima, Wash.:			
Sunnyside Unit	62,800	84,650	71,531
Tieton Unit	15,008	26,400	20,880
Shoshone, Wyo	16,524	38,282	26,421

fact that the main canal is short and the distribution system is compact.

It is evident from Table IV that 25 per cent is about the minimum loss that could be safely assumed under favorable conditions and that 50 per cent is sufficiently high under unfavorable conditions.

Table V is a statement of the irrigated areas of the several projects, which is needed to give the reader a more comprehensive understanding of the figures in Tables II, III and IV.

Tests on Finely Ground Cement

COMPARATIVE strengths of concretes made with standard and with finely-ground portland cement have been reported by the U. S. Bureau of Standards. The two cements were tested in 1 : 1½ : 2; 1 : 2 : 4, and 1 : 3 : 6 concretes of two consistencies, as well as in a neat mix, and in a 1 : 3 standard sand mortar. The following results and conclusions were obtained:

The strengths of concrete made of the fine cement were regularly and consistently greater than those made with the normal cement so far as the tests have been completed.

The percentage increases in strength of the fine cement concretes over the normal cement concretes were:

	2 days	7 days	28 days	3 months	6 months
Minimum	90	50	30	21	14
Average	121	66	56	41	42

It should be noted that the difference in fineness between the two cements was 12 per cent and to obtain the per cent increase in strength for each per cent increase in fineness. the figures in the above stable showing the increase should be divided by 12. The normally ground cement had 86 per cent passing the 200-mesh sieve as compared with 98 per cent for the finely ground material.

These percentage increases were highest at the earliest ages and the leanest mixes.

The strength increases of fine over normal cement concrete were greater in the mixes containing the greater proportions of cement.

If the two cements had been used on a job, the following approximate mix proportions could have been used to give the same strength at 28 days, if consistencies and aggregates were the same:

Using Normal Cement	Using Fine Cement	Approximate Saving in Bags of Cement per Cubic Yard
1 : 3½	1 : 5	2.1
1 : 4½	1 : 6	1.5
1 : 6	1 : 8	1.2

(Proportions were one part of cement to sum of volumes of sand and gravel measures separately.)

When used in 1 : 3 mortar, the fine cement produced a more marked percentage increase than when used in the concretes. The percentage increases in the neat mixture, however, were of the same order as in the concretes. Thus. in the cases of cements tested, the results of the work in neat cements gave a better indication of their value in concrete than tests in a 1 : 3 Ottawa sand mortar.

In most cases, the fine cement required no more water than the normal cement to produce a given consistency, when the aggregates and mix were the same.

It was found that when the special cement was tested for fineness on the 200-mesh sieve, the lumps of very fine material were not broken up under the sieving action and would not pass through the meshes, but when this cement was tested by the air analyzer these lumps were broken up and the results thus secured gave a true indication of the fineness of the cement. It is, therefore, recommended that the air analyzer be used in determining the fineness of very fine cement whenever possible, but that if this cannot be done care be taken to prevent this balling on the 200-mesh sieve if the determination is made in the usual manner.

The Geologist as Engineer

THE GEOLOGIST of the early part of the century, intent on the great fundamental problems of the science, on the discovery of the principles of erosion, intrusion, the succession of strata, and the studies in biological development associated therewith, scarce seemed to have any direct contact with practical affairs. With the further progress in these and other branches, however, each and all have been found to have a practical application, and the development of a type of geologist who has specialized as geological engineer, studying and applying the principles of the science to industry, has been rapid, until today there exists a numerous and important profession.

Most notable has been the development of the geologist who specialized in mining problems, and further specialization has taken place into metalliferous deposits, coal, oil, and non-metalliferous (as commonly so called), and even into quarrying. Regarded at first by the mining engineer (himself just newly arrived) with the same collegiate upper-class man contempt which the miner had accorded to him, the geological engineer in mining has won all the recognition due him and has taken his permanent place in the industry. Meanwhile, the geological engineer is also finding fields of usefulness in railroad and bridge, dam, subway, and other engineering work, in problems of water supply, road-building, land classification, and even in military science and problems of governmental policy.

The geological engineers at present far outnumber the geologists, much as the mechanical engineers outnumber the students of mechanics and physics. The affiliations of the geological engineer are naturally mainly with other engineers; the geological engineer specializing in mining has affiliated himself with the mining engineer, and has indeed, become one of the varieties of mining engineer into which specialization has led; and is so recognized. His main field of development, so far as it depended on organization or association, has been in the Institute of Mining Engineers, the name of which organization, in deference to the progressive specialization, has been recently changed to the Institute of Mining and Metallurgical Engineers, and we understand would have been the Institute of Mining Metallurgical, and Geological Engineers, except for the unwieldiness of the name. At present the presidents of our two great mining societies—Winchell and Lindgren—are both geological engineers.—*Engineering and Mining Journal.*

Milwaukee Water Supply Again Has Tastes and Odor Difficulty

A recurrence March 8 of the obnoxious tastes and odors in the Milwaukee water supply, which have been absent, with the exception of a slight taste Dec. 9, 1919, since closing the chemical plant of the Newport Hydro-Carbon Co., at Carrolville, early in 1919, has led the authorities to carry on an extensive investigation. The work is being done jointly by the city and State Board of Health to determine where the pollution comes from and to suggest remedies for its removal. Former investigations reported in the *Engineering News-Record*, Jan. 23, 1919, p. 181, indicated that the tastes came from chlorinating a water polluted with coal-tar derivatives from coke and phenol plants. One part of phenol in 500,000,000 parts of water gives a taste reaction with chlorine.

Marine Railway for 5,000-Ton Ships at Astoria, Ore.

Cradle on Inclined Track With Motor-Driven Chains Hauls Out Vessels for Repair—Compares Favorably With Dry Dock for Ships of Moderate Size

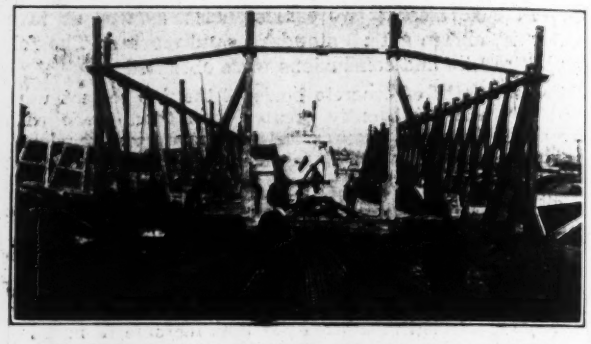
BY C. O. CRISMAN
Denver, Col.

DURING the war a number of marine railways were built by the Emergency Fleet Corporation, as one of its steps in increasing the dry-dock facilities of the country. The largest is a 5,000-ton railway at Astoria, Ore. It represents a type of structure having certain distinct advantages over the graving dock.

A marine railway, for docking ships for repairs, calking and painting or the installation of machinery, consists of an inclined track which extends under water far enough to permit a vessel to be floated upon a traveling cradle and far enough from shore to permit bringing the vessel entirely out of the water when the cradle is hauled to the upper end of the track. A docking device of this type can be built in less time and at less cost than a dry dock of equal capacity, but the capacity is limited.

The location of the Astoria marine railway, on Young's River at its confluence with the Columbia River, about 10 mi. from the mouth of the latter, has the advantage of being in fresh water, where the average tidal range is only 7½ ft. and the weather is mild throughout the year. The lifting capacity of 5,000 gross tons is distributed over a keel-block length of 380 ft. on a cradle 74 x 380 ft. At mean high water the cradle in its outer position has 18 ft. and 23 ft of water over the keel blocks at the forward and outer ends respectively. When hauled out its deck is 2 ft. above water level. A similar railway of somewhat smaller capacity, at Alameda, Cal., is shown in the view. The general design of the Astoria railway and cradle is shown in accompanying drawings.

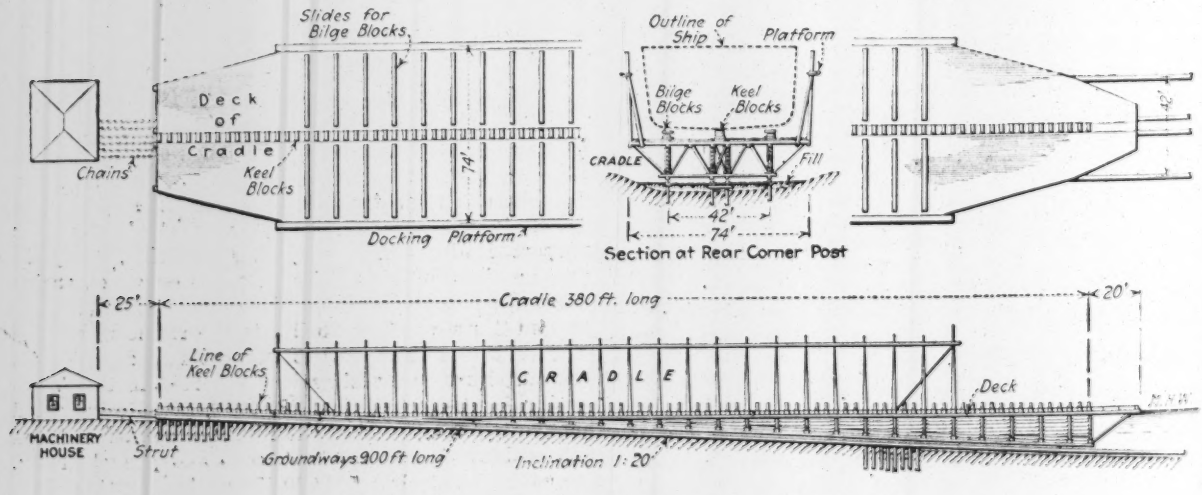
A slope of 1 on 20 is used for the track and groundways. The site was excavated and dredged 2 ft. below the pile cutoff, which ranges from zero to 42½ ft. below mean high water, the excavation having a bottom width of 52 ft. and side slopes of 1 on 2 to 1 on 3. After the groundways were built, material was backfilled nearly to the track level. Four rows of piles were driven to carry the four longitudinals and rails, the pile spacing being from 4½ to 8 ft. under the outer rails and from 2½ to 6 ft. under the inner rails. Near the upper end of the ways, inclined spur piles were driven along the center line, in order to anchor the structure in position and to resist any tendency to longitudinal movement. The piles at the upper end were required to be of sufficient size and length to sustain a bearing load of 21



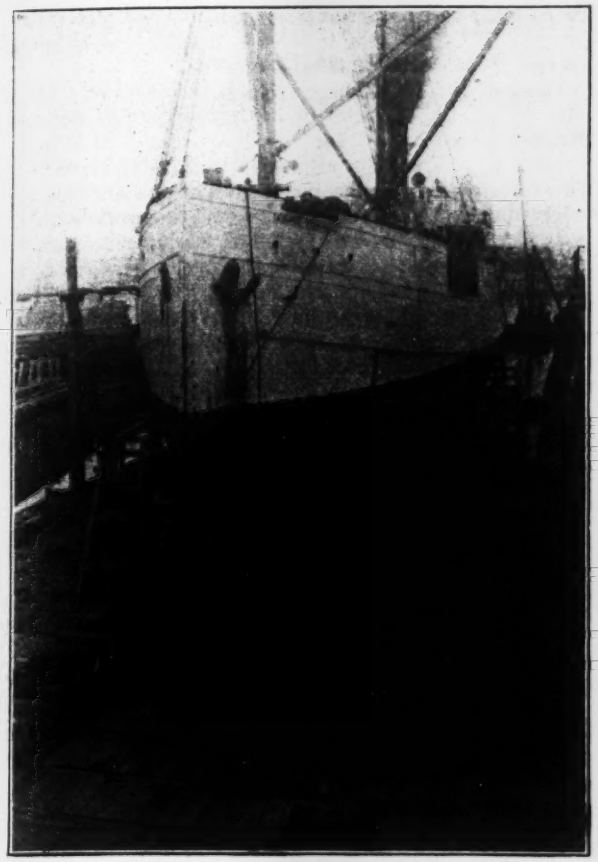
CRADLE BEING LOWERED IN 4,000-TON MARINE RAILWAY AT ALAMEDA, CAL.

tons each, this load being reduced gradually to 16 tons at the outer end. Lighter load and longer spacing for piles at the outer end are permitted because of the buoyancy of the ship and cradle.

The groundways, 900 ft. long, consist of four longitudinals spaced 6 ft. and 42 ft. apart, each composed of three layers of timbers bolted together. The longitudinals are driftbolted to the piles and secured by cross-timbers and diagonal bracing. Above low water the ways were built in place; for the 650-ft. stretch under water they were constructed on shore in sections more than 200 ft. long, launched, floated into position and sunk by weights, the bolts then driven by a diver.



CRADLE AND WAYS OF MARINE RAILWAY



STEAMER SECURED IN CRADLE

Chain paths of 3-in. plank fastened to the cross timbers extend from the upper end to the downhaul sheaves. Four flat steel rails 1 to 1½ in. thick are laid on the longitudinals and secured by countersunk bolts, the inner rails being 12 in. and the outer rails 6 in. wide.

Four longitudinals or runners forming the base of the cradle are faced with similar flat rails, and between the two sets of rails are 4-in. double-flanged cast-iron rollers, spaced 10 in. apart. These rollers are held in wooden frames forming continuous roller nests which extend 630 ft. down the track, this distance being sufficient to provide rollers under the cradle at any position. Timber framing forms the superstructure of the cradle, the buoyancy of which is overcome by 550 tons of ballast filled between the main deck and sub-planking under the deck beams.

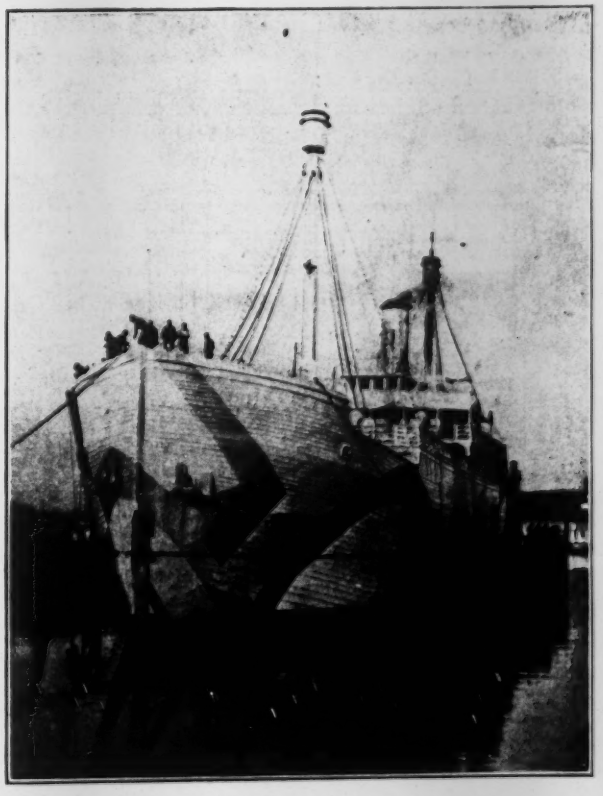
Bilge blocks to support the vessel laterally are spaced 12 ft. apart on each side of the deck of the cradle and have a transverse travel on slides carried by the main deck beams. They are moved by chains passing through lead blocks and operated by hand winches along the top of the cradle. Platforms are provided for working these winches and handling the ropes for bringing the vessel into position. The keel blocks and bilge blocks are of such height that there is room for men to work between the deck of the cradle and the bottom of the vessel.

Chains are used for hauling the cradle. They are operated by sprocket wheels driven by a 250-hp. motor through a train of gearing. Slow speed is provided for heavy loads and higher speed for moving the cradle when empty or carrying light loads. The machinery is anchored to a heavy base of reinforced concrete. Struts of the same material are placed between this base and the head of the groundways, to take the thrust in hoisting and to prevent any sliding of the machinery foundation.

Six uphaul chains of the open-link type are attached to the cradle through a system of equalizing sheaves to maintain an equal distribution of the stress. They are of wrought iron, 2 to 2½ in. in diameter, this variation allowing for the increase in stress as the loaded cradle emerges from the water. Six downhaul chains attached to the cradle are led through sheaves secured to the groundways 594 ft. from the upper end, so that power can be used in lowering the cradle. These chains are of 1¼-in. iron. Slack in the chains can be eliminated by shortening the bridle chain which carries the equalizing sheaves.

The power required to raise the loaded cradle depends upon the friction to be overcome. With an inclination of 1 on 20 the lifting force amounts to 5 per cent of the combined weight of vessel and cradle; friction will vary with the alignment of track, distribution of load, accuracy of rollers and condition of rails, but in a well built railway it should not exceed 4 per cent. Any additional stress due to starting is small, as at that time the cradle is submerged and the vessel practically floating. The total power necessary will be approximately 9 per cent of the entire load to be raised.

In preparing to dock a ship, the cradle being at its upper position, the heights of the keel blocks are adjusted to conform to the shape of the ship's keel, and the bilge blocks are adjusted to support the hull laterally. The cradle is then run down the track until it is in sufficient depth of water for the ship to be floated over



CRADLE AND STEAMER HAULED OUT OF WATER

the keel blocks and secured in position by ropes operated from winches at the corners of the superstructure. The cradle is then started, but as soon as the keel touches on the keel blocks at any point, it is stopped until the bilge blocks are moved into their corresponding positions in contact with the hull.

Then the cradle is moved again until the vessel rests at another point, this series of operations being repeated until the entire length of the vessel is supported. Further progress of the vessel and cradle up the ways is continuous. About an hour is the time required for getting a vessel out of the water. When the repair work has been completed the cradle is lowered until the vessel floats off. It is then hauled out ready for adjusting the keel and bilge blocks for the next vessel.

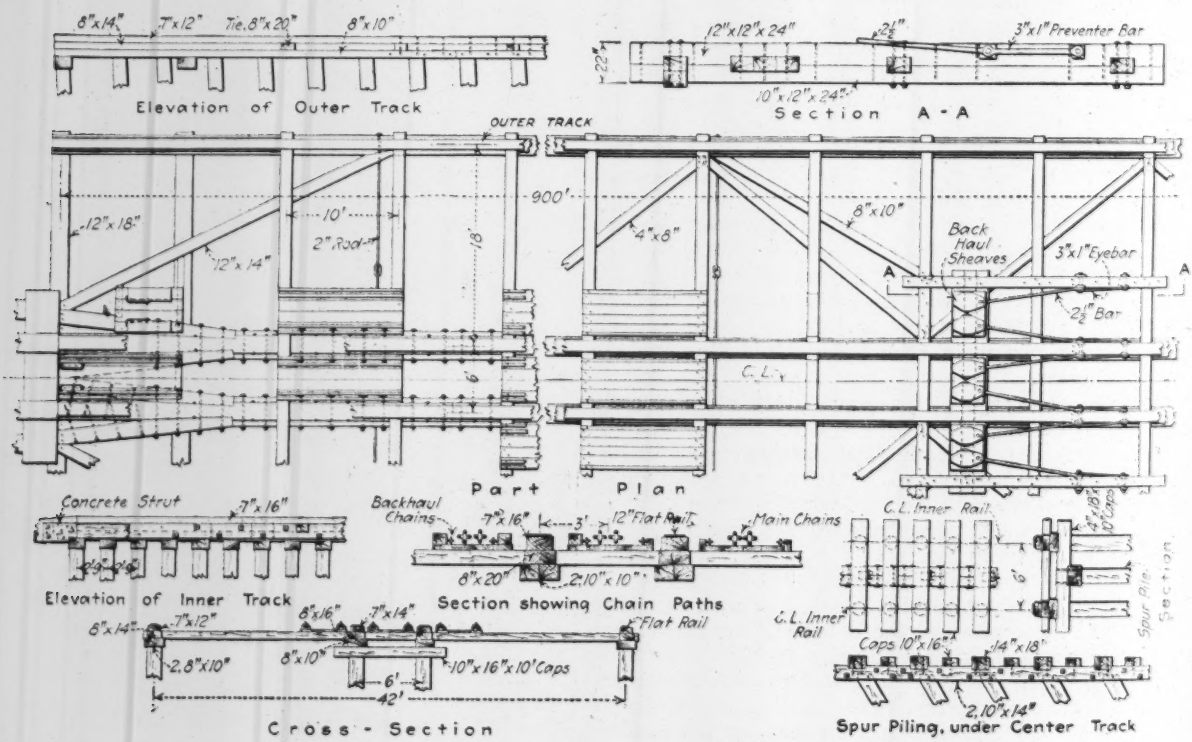
Speed of operation is one of the advantages of a marine railway, the time necessary for docking being usually from three to four hours. This short time directly affects the labor costs. Another advantage is the close proximity to the repair shops. As the cradle is open on all sides and its floor is practically at the level of the ground it gives greater accessibility than do docks, and the handling of heavy materials is facilitated. Traveling cranes are sometimes provided alongside the upper portion of the ways. Maintenance cost is low owing to the simplicity of the structure.

The application of the marine railway is subject to certain limitations. The length of groundways usually must be about three times that of the longest vessel to be handled, depending somewhat upon the length and draft of vessel and the tidal variation. Therefore, in most cases the outer portion will be in a pocket dredged below the bottom of the channel, so that it is difficult or impossible to keep the tracks clean. This trouble increases with the length of the ways. For the foundation, the bearing power required varies directly with the load, and the conditions at each site will determine whether it is possible to secure a pile spacing close enough to meet the load requirements.

The cost of foundations and ways increases so rapidly with the depth of water that this system of docking becomes uneconomical for the great length and depth of submerged structure required for ships of great size. To shorten the haul, the inclination of the groundways might be increased, but this would necessitate more powerful hauling machinery, while experience indicates that a grade of 1 on 20 is preferable to a steeper inclination. The cradle could be made large enough for any vessel, but as all the hauling stress is taken by its inner longitudinals any large increase in stress would involve construction difficulties.

As the hauling chains operate over toothed sprocket wheels, uniformity of the links is essential, but the size of chain is limited by the fact that a 2¼-in. or 2½-in. chain is about the largest size that manufacturers can guarantee to be uniform. It is possible to use any desired number of chains, but the difficulty of transmitting and distributing the stress to the frame of the cradle increases with the number of chains. On the basis of all these conditions a capacity of 5,000 gross tons dead weight has been determined upon by marine engineers as the present economic limit.

The marine railway at Astoria, Ore., was designed by the Crandall Engineering Co., Boston, Mass., the construction being done in co-operation with the Astoria Marine Iron Works. The work was carried out under the direction of Captain R. E. Bakenhus, manager of the division of shipyard plants, Emergency Fleet Corporation, Philadelphia, Pa., and J. W. Ferguson, district plant engineer, Portland, Ore. The writer was resident engineer. The estimated cost is $204,000 for the railway, cradle and operating machinery.



GROUNDWAYS OF MARINE RAILWAY AT ASTORIA, ORE.

Engine Terminal for Mountain Division in Utah

Rectangular Enginehouse Without Turntable Avoids Snow Troubles and Utilizes Space—Ash Removal by Steam Jets

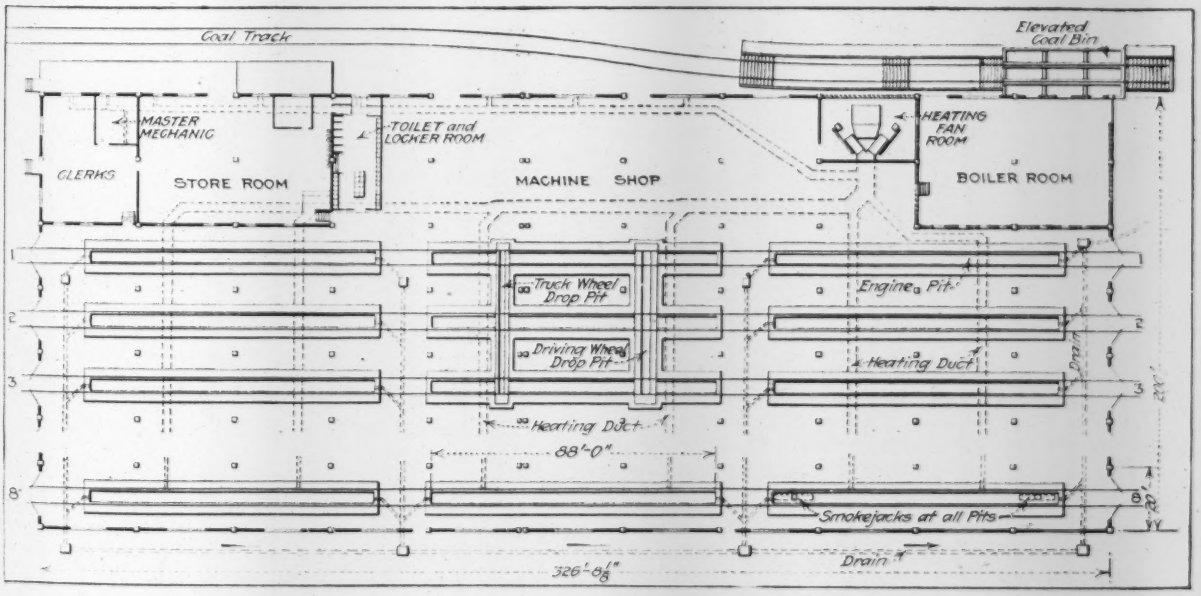
SNOWFALL, climatic conditions and restricted space were governing features in the design of the engine terminal for the new division point established by the Denver & Rio Grande R.R. at Soldier Summit, Utah, the location being the crossing of the Wasatch mountains at an elevation of 7,440 ft. above sea level. A rearrangement of operating divisions was made in order to secure greater efficiency in the handling of heavy traffic, and extensive yards are provided for classification and assemblage of cars, as described in *Engineering News-Record* of May 27, 1920, p. 1069. A 24-stall rectangular concrete enginehouse, a steam-jet conveyor system for handling ashes and a Y-track instead of a turntable are important features of the terminal. There are three yard engines and twelve Mallet pusher engines stationed at this point, besides which the terminal has to provide facilities for cleaning, running repair work and supply of coal and water for about fifty engines daily.

The selection of this unusual type of enginehouse, rectangular in plan and having parallel tracks served by switch connections, instead of the ordinary segmental or circular roundhouse with radial tracks served by a turntable, was based largely upon the difficulty of keeping a turntable pit free from drifting snow under the severe climatic conditions which occur at Soldier Summit. Another reason was that for housing long Mallet engines a roundhouse requires an excessively large area, so that the rectangular arrangement gave a more economical utilization of the restricted space available. Estimates showed that the cost would be about the same for the circular and rectangular arrangements at this point.

In the design and location of the rectangular engine house without turntable, provision had to be made for turning the engines by means of a Y-track so arranged as to require a minimum movement of the locomotives. To meet this condition it seemed desirable to locate the building within the area enclosed by the Y-track, as shown on the plan. Further, it is necessary to secure a switch layout which will facilitate movement to and from the enginehouse tracks. Eight parallel tracks spaced 20 ft. c. to c. extend through the building and are connected at each end to a diagonal lead, these leads being continued to a junction so as to form the Y-track for turning the engines. Each house track can accommodate three engines, giving a total capacity for 24 locomotives.

Reinforced concrete of the unit type construction is used for the enginehouse, which is 200 x 326 ft. in plan. Brackets or corbels are formed 7 ft. below the tops of the columns, so that girders seated on the heads and brackets form alternate high and low bays extending across the building. In the high bays or monitors, the roof is flat and the vertical faces are filled with stationary and pivoted sash. In the low bays, a ridge arrangement transverse to the tracks is used for the purpose of good drainage. Concrete slabs of channel section resting directly upon the longitudinal girders form the roof covering and are sheathed with two layers of roofing paper mopped with hot asphaltic composition. Simple footing blocks support the columns. Large window areas are provided in the concrete side walls. In the end walls are track openings 14 x 18 ft. fitted with wooden double-leaf swinging doors.

Each of the 24 engine pits is 88 ft. long, and has 36-in. reinforced concrete walls capped with jacking timbers. Between the pits the floor is of gravel, level with these timbers. Flat base plates support the 85-lb. track rails which are secured by nuts and by circular clips on inclined anchor bolts. Three of the pits are connected by a pair of deep transverse drop pits in which travel trucks with 10-ton pneumatic jacks for handling wheels and axles, one drop pit be-



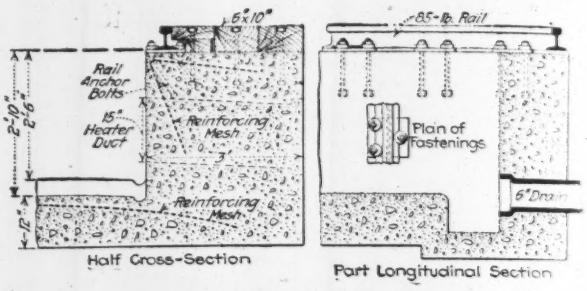
PLAN OF RECTANGULAR ENGINEHOUSE

ing for driving wheels and the other for truck wheels. Swinging girders carry the track rails of the engine pits across the drop pits. As heavy repair work will not be done at this terminal, no overhead traveling crane or power jack lifting equipment is provided, the engines being raised by portable hand jacks when wheels have to be removed. Drainage of the pits is afforded by sloping the floor from the middle to each end, where drains are connected. Over each end of the pit is a wooden smoke jack with open flue, no damper being provided.

For the heating system, air heated by passing over steam radiators is delivered into a system of ducts by two fans, each having a discharge capacity of 27,000 cu.ft. per min. From a longitudinal duct along one side, six ducts extend across the building, reducing from 30 in. to 15 in. in diameter and having 15-in. tile branches from the tops of the conduits to the sides of the pits. Each pit has two of these branch conduits. Overhead mains for steam, water and compressed air are carried by brackets on the columns and have drop pipes with service connections at all the pits.

Electric lamps suspended from the girders provide for general lighting and connections are provided on the columns for the attachment of extension cords. All electric conduits are embedded in the concrete. Along the north side of the main floor is the machine shop, which is not separated from the engine space but has an enclosed store room and office at one end and a boiler room and fan room at the other end. An elevated 200-ton concrete bin approached by an inclined track holds coal for the stationary boilers and a steam conveyor system with 8-in. pipe removes the ashes to a dump 150 ft. distant. For washing out the engine boilers with hot water there is a separate plant with heaters and pressure tanks.

Steam jet conveyor systems provide for the removal of ashes from the boiler house and from the ashpits where the locomotives have their fires cleaned or dropped. This method of handling ashes was adopted mainly because of the difficulty of loading wet cinders into cars during the winter and the attendant cost and difficulty of emptying the cars. The topography was

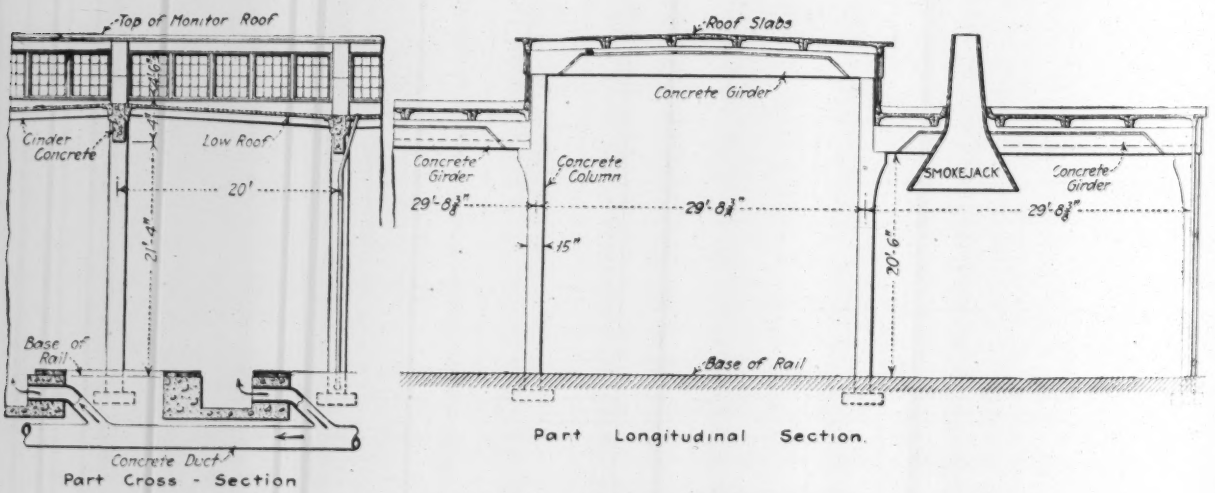


DETAIL OF REPAIR PITS

favorable to the steam system, as there was a large depression available into which the cinders could be blown and disposed of without further cost. During mild weather it is proposed to blow the ashes into cars for use in filling at various points. From the boiler house ashpit, the ashes are blown through an 8-in. pipe to a dump 150 ft. distant. A water filled ashpit served by a gantry or locomotive crane with grab bucket was considered for handling ashes from the engines, but the steam conveyor system was adopted as preferable.

Locomotives which require cleaning of fires are served by two concrete ash hoppers on a pair of tracks spaced 20 ft. c. to c., the hoppers being staggered in position and having sloping sides so as to deliver the ashes by gravity at opposite ends of a pit between the tracks. In a trench along the floor of the pit is an 8-in. cast-iron pipe having an open-end tee opposite the bottom of each hopper. From one end of the pit the pipe is diverted at an angle of 45 deg. and carried horizontally underground 175 ft. to a gulch into which the ashes are discharged. At the opposite end of the pit, the pipe has a vertical riser connected to an overhead pipe carried across the adjacent engine track by a latticed girder and ending in a spout for discharging ashes into a car on an outer track.

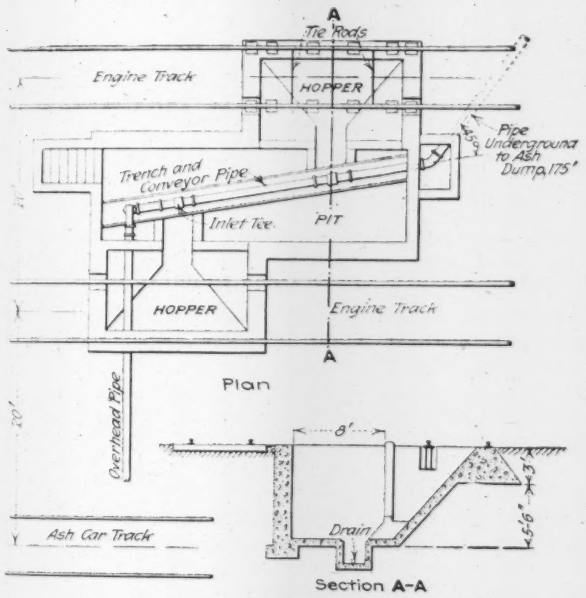
A 2-in. steam jet enters each end of the pit pipe, so that ashes can be moved in either direction as required. Steam is piped 500 ft. from the boiler house and has a pressure of 80 to 120 lb. One man attends to the valves and assists the gravity feed of ashes



ENGINEHOUSE BUILT OF CONCRETE UNITS

to the pipe inlets if necessary. Each locomotive drops an average of 1.3 cu.yd. and the total amount handled daily is about 65 cu.yd., in addition to which the boiler house conveyor handles about 2 cu.yd. daily. One rail of each ashpit is carried by a girder composed of a pair of I-beams spanning the sloping face of the hopper, the other rail being carried upon the concrete wall. Both rails are secured to flat base plates by bolted clips, gage being maintained by tie rods in spacing sleeves.

A 300-ton coaling station of timber construction has been built. It has ten elevated pockets and chutes placed in two rows and serving two engine tracks spaced 45 ft. c. to c. and is approached by an inclined trestle with a grade of 6 per cent, which extends 80 ft. beyond the pockets and up which hopper bottom coal cars are pushed by a locomotive. Under the extension or tail trestle is a bin for wet sand. After the sand has passed through steam heated driers it flows by gravity to steel drums buried in the ground, from which it is blown by air at 80-lb. pressure to overhead bins supplying the locomotives.



ASHPIT WITH STEAM-JET CONVEYOR

A gravity water supply is brought from Price River by a 12-in. wood stave pipe line 4 mi. long and is delivered to a 1,000,000-gal. concrete reservoir on high ground behind the terminal, the water level in the reservoir being 40 ft. above rail level. For watering the engines there are two 50,000-gal. elevated wood tanks, one of which has two spouts for direct delivery to engine tanks of different heights and the other serves a 12-in. water column. Electric current for light and power is taken from the Utah Light & Power Co.'s transmission line which passes over the range and serves the coal mines on the east slope of the Wasatch Mountains.

The new engine terminal at Soldier Summit was designed and built under the direction of J. G. Gwyn, chief engineer, Arthur Ridgway, assistant chief engineer, and W. W. Lemen, superintendent of motive power, Denver & Rio Grande R.R.

Sewage Effluents for Disposal With and Without Dilution

Results To Be Aimed At and Methods To Be Employed—What May Be Accomplished By Various Means Commonly Considered

THE major portion of the report on Sewage Works Operation, submitted to the Sanitary Engineering Section of the American Public Health Section late in October, 1919, related to standards for sewage effluents to be disposed of (1) without and (2) with dilution. The committee was composed of C. B. Hoover, Columbus, Ohio; W. L. Stevenson, Harrisburg, Penn.; C. E. A. Winslow, New Haven, Conn.; Paul Hansen, Springfield, Ill., and Robert H. Morse, Baltimore, Md. An abstract of the report follows:

The following characteristics are proposed for an effluent which will not require dilution and which will insure a satisfactory stream condition.

1. A reasonable freedom (less than 0.5 cc. per liter) from suspended matter.

2. Total suspended matter content not to exceed 25 parts per million.

3. Oxygen demand not to exceed 10 p.p.m. after 24 hr. at 37 deg. C.

4. Nitrate and nitrate nitrogen content which would represent a fairly complete mineralization of the nitrogenous matter.

5. Chlorine treatment wherever a low bacterial count is deemed necessary.

It is not to be inferred that an effluent must equal these characteristics in order to show a 100 per cent stability value by the methylene blue test for an effluent inferior in quality to the one proposed may show a 100 per cent stability value but it will not be apt to insure a highly satisfactory stream condition.

An effluent of the character proposed may be produced by the following prccesses: (1) Sand filtration. (2) Sprinkling filters followed by efficient sedimentation. (3) Activated sludge.

There are many factors which must be considered in determining sewage treatment requirements where dilution is available. Among these are the characteristics of the stream such as velocity of flow, normal summer and minimum rate of flow, the uses to which the stream is or is apt to be put, the present and probable future values of riparian properties, climatic conditions, etc. Under suitable conditions, a stable dilution for municipal sewage may be obtained with from 4 to 6 sec-ft. of relatively clean water per 1000 people contributing sewage.

Where raw sewage is to be discharged into a stream where the dilution is thought to be adequate, the desirability of removing the coarsest suspended matter by screening or rapid sedimentation will be governed by local conditions. Where the available dilution is such that more thorough treatment is necessary, the practical question before the operator is, what is a reasonable expectancy from the various types of sewage treatment devices.

1. *Fine Screening.*—A removal of from 5 to 15 per cent of the total suspended matter may be reasonably expected.

2. *Sedimentation.*—A reduction of from 25 to 30

per cent in the dilution requirements is a reasonable expectancy from efficient sedimentation. The efficiency of sedimentation should be determined on the basis of the removal of settleable suspended matter by volume or by weight, preferably the latter. The efficiency may be determined volumetrically by use of the conical settling glasses, and gravimetrically by inserting, at the end of the two-hour settling period, a rubber stopper attached to a glass rod, in the conical settling glass of the raw sewage to a point just above the top of the settled solids, pouring off the supernatent liquor and determining the suspended matter in it by the Gooch method. The suspended matter in the supernatent liquor represents the non-settling solids and this value subtracted from the total suspended matter value of the raw sewage will give the settleable solids by weight. The total suspended matter by weight into the settleable suspended matter by weight will give the per cent of the total suspended matter of the raw sewage that is settleable. The per cent of removal by weight of total suspended matter by the tanks divided by the per cent of settleable solids by weight will give the removal of settleable solids by weight by the tanks. It is proposed that the following standard in terms of percentage removable of settleable solids be applied to sedimentation results:

Ninety or more, excellent; 80 to 90, good; 70 to 80, fair; less than 70, poor. The percentage of removal of settleable solids on the volumetric basis, as determined by the conical settling glasses, is ordinarily considerably less than on the gravimetric basis (sometimes 10 to 15 per cent).

3. *Bacterial Oxidation.*—Under this heading will be considered sand filtration, sprinkling filters, and activated sludge.

When a sand filter fails to produce an effluent equal to or better than the one proposed above for an effluent which does not require dilution, there is something radically wrong and the filter may be regarded as not functioning normally, as freedom from settleable suspended matter, a high degree of oxidation of nitrogenous material, and a low bacterial count, are normal characteristics of sand filter effluents.

Sprinkling Filters.

The normal characteristics of the effluent from a sprinkling filter which is dosed with well settled sewage, are as follows:

1. From 10 to 20 per cent less total suspended matter than in the applied sewage.

2. From 2 to 10 times as much settleable suspended matter as in the applied sewage.

3. Oxidized nitrogen in the form of nitrates and nitrates to the extent of from 1 to 10 parts per million.

4. Reduction in the oxygen demand of the applied sewage of from 50 to 90 per cent, 80 per cent being a reasonable expectancy.

5. A reduction in the total bacterial count of the applied sewage of from 40 to 70 per cent, 60 per cent being a reasonable expectancy.

A well designed and properly constructed sprinkling filter, operating under optimum conditions with respect to the total dose and its distribution, and followed by efficient sedimentation, should produce an effluent which will not require dilution. Efficient sedimentation will reduce the total suspended matter content, practically eliminate the settleable material, and reduce the oxygen demand. Sprinkling filter effluents which have not the characteristics proposed for effluents not to be diluted will require more or less dilution and when four or more parts of diluting water are required for stability, the effluent is a poor one although it may be satisfactory for some particular case.

Activated Sludge.

The normal characteristics of activated-sludge effluents as produced experimentally are as follows:

1. Low total suspended matter content.
2. A practical absence of settleable suspended matter.
3. Presence of oxidized nitrogen as nitrites and nitrates in amounts equivalent to or better than in sprinkling filter effluents.
4. A low oxygen demand.
5. A high reduction in total bacterial count.

The normal expectancy from this process of treatment when operated as a municipal function rather than on a special experimental basis, has yet to be demonstrated. If a plant of this type is turned over to an operating personnel of the usual type, it is very apt to be a dismal failure as other types of treatment works using less particular processes of treatment than those employed in activated sludge have often failed to give satisfactory service through a lack of competent supervision.

Middle Atlantic States Road-Building Program

According to a report by Samuel Knopf, assistant engineer Delaware State Highway Department, and read before the fifth annual meeting of the American Association of State Highway officials held recently at Louisville, Ky., the highway program contemplated by the five Middle Atlantic States comprising New York, Pennsylvania, Delaware, New Jersey and Maryland, includes the construction of about 2,100 mi. of hard-surfaced highways at an expenditure in the neighborhood of $100,000,000. Just what amount of this program will be carried to completion depends not upon the amount of funds but upon those same limiting factors that operated during the 1919 season—amount of labor and materials available, transportation, and the lack of experienced and fully equipped contractors' organizations.

The program to be carried out requires the moving of 11,500,000 tons of aggregates, which includes the tonnage required to complete the projects carried over from this year's work To this also must be added the tonnage of aggregates required in the resumption of building operations, railroad improvements, street work, maintenance of roads, etc., which have been seriously curtailed during the war and the year 1919 waiting for decreases in prices. "To meet this tremendous demand for materials successfully," says Mr. Knopf, "transportation facilities must be improved; plant capacities enlarged, and production increased. Each is supplementary to the other. The development of one, without the development of the other, would tend to increase rather than minimize a difficult situation."

Wide-Spaced Stockpiles and Wet Haulage Successful

Stock Storage Ahead of Construction Aids Progress—Road Grade Completed to Profile Without Stakes

SUCCESSIVE mixing plant set-ups at stockpiles 500 ft. apart, and wet haulage of concrete, have given successful results on the Gray's Lake-Volo Road in Lake County, Illinois. Steady operation has been assisted by the large accumulation of stock ahead of construction. Construction itself is according to the specifications of the Division of Highways of Illinois, and 16-ft. concrete slab has been finished at the rate of 50 ft. an hour. With the wrinkles in operating procedure ironed out an average progress greater than this is anticipated, but, including lost time in shifting plant, 500 ft. a day has

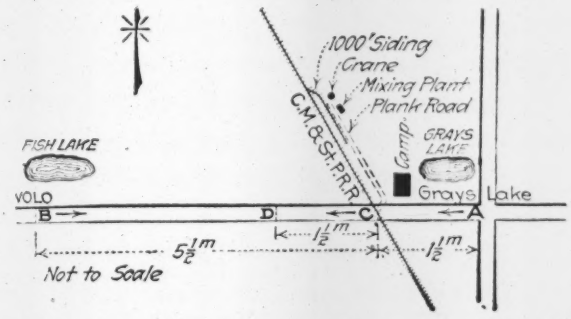


FIG. 1. CONSTRUCTION PLAN FOR GRAY'S LAKE-VOLO HIGHWAY

represented high output with team haulage of concrete. Near the close of last season, when truck-tractors were substituted for teams, 550 to 575 ft. was the high output, with stockpiles 600 ft. apart.

Besides the distinctive character of the concreting plant and methods, the work from Gray's Lake to Volo has developed unusual grading methods. Workmen finish the subgrade directly from the engineers' notes without stakes. Exact surface and profile, within the small variation permitted by the Illinois State specifications, are secured with blade graders and Fresno scrapers.

From Gray's Lake to Volo is 7 mi. An old water-bound macadam of poor surface but giving a hard track, extends the length of the new work. At about 1½ mi. east of the Gray's Lake end, as indicated in diagram by Fig. 1, the Chicago, Milwaukee & St. Paul Ry. crosses the highway and provides the nearest railway connection for materials and equipment. A 20-car siding was put in and was connected with the highway by a 10-ft. plank road built very solidly of 3-in. maple planks on 3 x 12-in. stringers. Curb timbers were placed at the edges of the road, as shown by Fig. 2, to keep the truck wheels directly over the stringers. With the old macadam, this plank road provided a substantial hard track for trucks the full length of operations. The order of these operations was, with a portable outfit, to pave the stretch from *A* to *C* and then transfer the outfit to *B* and work east to *D*. In the meantime, by wet haulage from a stationary mixer at the siding, the section *C-D* can be constructed.

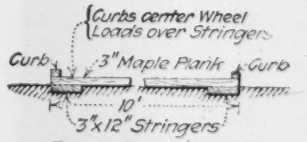


FIG. 2. CURBS ON PLANK ROAD CENTER LOADS OVER STRINGERS

Station B. M.	Dist. Stake to C.L.	Grade Differences	Elevations: Grade	Elevations: Sub-Grade	Rod Readings	N. Side Road	Center Line Road	S. Side Road
B.M.			203 13	203 38	0 25			
363+00	30'		203 50	202 84	0 54	2 F2	3 F2	4 F2
+12 5					1 04	7 F3	6 F2	5 F5
+25					1 54	8 F3	9 F2	10 F1
+37 5		−1.99			2 04	13 F3	12 F2	11 F3
363+50			201.51	200.85	2 53	14 F2	15 C1	16 G
+62 5			.....	.....	2 92			
+75		−1.55	.....	.....	3 31			
+87 5					3 70			
364+00	31'		199 96	199 30				

FIG. 3. EXAMPLE OF ENGINEERS' NOTES FOR FINISHING SUBGRADE

GRADING WITHOUT STAKES

Grading ran about 4,000 cu.yd. per mile in cuts and fills of from 2 to 4 ft. The old macadam is loosened with a scarifiier pulled by a 10-ton roller. Then the roller, operating a heavy railroad plow, turns the material to a depth of 12 in., repeating the plowing as many times as is necessary to loosen the cut to depth. Fresno scrapers, operated by three horses, move the material. From four to six scrapers are employed, the operators working to grade stakes set every 50 ft. by the county engineer. This is the rough-grading operation.

The finish-grading outfit consists of the roller, a medium-heavy road grader and one Fresno scraper. Four or five passes of the roller and grader cut down the humps and fill in the hollows, and, with the Fresno to smooth up behind, complete the subgrade. There are five men in the finishing gang, one on the roller, one grader man, two grade men and a foreman. The finishing is in direct charge of the contractor's engineer, who eliminates the use and inconvenience of final stakes by checking the grade with frequent level shots during the day, from a set-up about midway of a 1,000-ft. section. The procedure in detail is best explained by the specific operation illustrated by Figs. 3 and 4.

In a notebook, the engineer transcribes from the plans and computes the figures given in the first six columns of Fig. 3. Each 50-ft. section is divided into quarters, as indicated in column 1, and a simple computation then gives the rod readings opposite the quarter points. With these the engineer and a rodman proceed to check up a 50-ft. section.

Using a 12½-ft. rod, readings are taken in the order numbered on Fig. 4 and are noted as indicated by Fig. 3. In the case noted a 2 to 5-in. fill is required over the section except at one point, where a 1-in. cut is required, and another point, which is at grade. This is a Fresno scraper operation, the operator being directed by the engineer or a grademan from the engineer's notebook. With his level standing, the engineer rechecks the elevations as often as is needed, alternating between the tasks of reading level and directing the scraper and grader operations.

On this work the use of Fresno scrapers has proved unusually effective in reducing the normal finishing operations. In roughing cut the grade, Fresnoes work as close as 1 in. without difficulty, the broad, flat edge permitting a planing cut to be made with great accuracy. On the fine finishing of sub-grade, a careful operator skins down humps and spreads the material into the hollows to almost theoretical perfection. Their quick

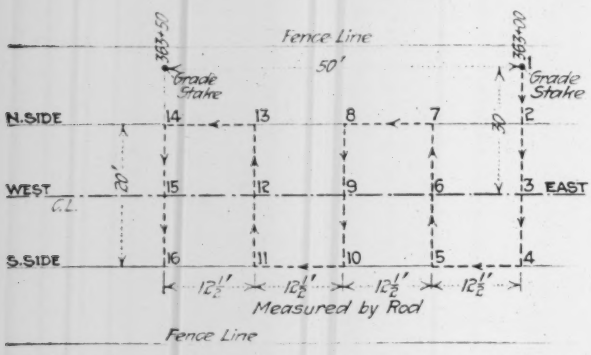


FIG. 4. SEQUENCE OF LEVEL READINGS IN CHECKING UP GRADE

dumping action and wide spreading discharge fit well into the operations of widening out the old road bed and making wide, flat fills.

Following the subgrading just ahead of the mixer is a form crew of three men. About 1,500 ft. of steel forms are used. They are set directly on the finished grade and require very little leveling up, owing to the accuracy with which the subgrade is finished.

Portable Mining Plant

Materials storage was the first operation of concreting. In fact it preceded in large part the grading. Broadly, the plan was, having the original macadam to give a hard track for motor trucks, to distribute the sand and gravel stock ahead of construction or virtually to store enough materials for the entire job as a preliminary operation before tearing up the old grade, and to put this stock in its final position for transfer direct to the mixer. This involved storage on the grade and therefore separate stockpiles so as to leave as much as possible of the old grade uncovered for the regrading operations. Stockpiles 500 ft. apart were estimated to afford about the relation between distance of wet haul, frequency of plant shifts and free space for grading operations that would be most economical. In placing the stockpiles, sand and cement were put on one side of the grade and gravel on the opposite side. Where the stockpiles came the roadbed was graded ahead of the regular grading operations when necessary.

Concreting is performed with a portable outfit comprising a charging crane, a mixing plant and a cement conveyor which are shifted to successive stock piles. The general arrangement is shown by the diagram Fig. 5. A platform on wheels travels on a track laid on the subgrade and carries a 15-cu.yd. charging bin for sand and gravel, a 1-cu.yd. mixer and engine, and a cement platform, measuring box and discharging hopper. The track, Fig. 6, on which the platform travels, consists of four twin sections of 30-lb. rail fastened to 3 x 12-in. oak planks. The platform is just high enough to allow the trucks or carts for wet-batch haulage to be backed under the discharge hopper. This hopper holds something over a batch, so that the supply of mixed concrete for the carts is practically continuous. Aggregates are loaded into the platform bin by a full revolving crane on caterpillars and operating a ¾-cu.yd. clamshell. Cement is handled from stock to the platform by a belt conveyor on a frame with wheels.

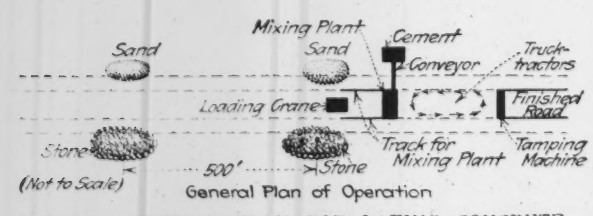


FIG. 5. GENERAL PLAN FOR LAYING CONCRETE PAVEMENT

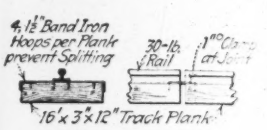

4-1½" Band Iron Hoops per Plank prevent Splitting
30-lb. Rail
1" Clamp at Joint
16'x 3"x 12" Track Plank
Mixer Plant Track Details

FIG. 6. DETAILS OF THE TRACK FOR PORTABLE MIXING PLANT

In shifting the plant, the crane travels by its own power, making the trips in about 10 min. The mixer outfit is hauled by the roller. With four men to take up and lay ahead the track sections, a shift requires about 30 min. A complete change of set-up requires about an hour. Including time of making the shift the plan of operations is to cover the distance between two stockpiles in a day's work.

Wet-Batch Haulage Improvements

Distribution of the concrete between mixer set-ups is a wet-batch haulage operation. At first ½-cu.yd. one-horse carts were used, six carts for five hours for long haul, and three carts for ten hours for short haul. With this outfit excessive time was consumed in backing the carts into place to receive and to discharge batches. Toward the end of the season, truck tractors were substituted for horse carts. Final improvements of the new haulage method had not been completed when cold weather stopped the concrete work, but the truck tractors had demonstrated the possibility of increasing the distance apart of stockpiles to 600 ft. and the high output to from 550 to 575 ft. of pavement a day.

The contractors for the Gray's Lake-Volo Road are Paschen Bros., Chicago, Ill. Walter M. DeBerard is engineer for the contractors in direct charge of field construction.

Salary Increase Arguments

In arguments for an increase of from 50 to 75 per cent in the salaries of the municipal engineers in St Paul, appearing in the *Bulletin* of the Affiliated Engineering Societies of Minnesota are the following statements:

Not one man in a thousand is aware of the fact that the Department of Public Works actually earns from 50 to 100 per cent of its entire cost of administration. In the main, this money is earned, to wit: (1) Through force-account paving work; (2) through renting out of tools and equipment, when not needed by the department; (3) through profits on numerous paving repair and other repair jobs of all kinds executed by the department for all public utility companies, private firms, etc.; (4) through charging of certain fees, which fees are for services rendered by the department.

On force-account paving work alone the saving to citizens in the last few years has amounted to about $100,000 as compared with the lowest bids received by contractors. What was saved on such work done by force account where no bids were asked for, or where no bids were received, can only be surmised and no definite proof can be furnished, but it is believed from the amount of work done and from the experience had on other work, at least another $100,000 was saved.

An Efficient Catalog File

By R. George Roesch
With Thompson & Binger, Inc., Engineers & Contractors, Syracuse, N. Y.

A POINT that most people have failed to take seriously, is that the systematic filing of catalogs for ready reference requires the same, if not more, thought and care as correspondence in any modern office. The system outlined herein will take more time to start than the old haphazard way of indiscriminate filing and the continual use of an index, *but*, it will save all that time and more when it is used. While there are variations without number, the method is given here just as it is successfully used and it is to be noted that there is room for much expansion without changing it in any respect.

"Cap" size drawer cabinets are handiest, the number used depending entirely on the number of catalogs to be filed. A card index of all catalogs, listed both according to manufacturers and to products, is also kept for the convenience of the uniniated, but no index will be required by those who understand the system.

First: All catalogs are considered as falling into *three* general groups, as seen by the contractor; "Plant"; "Building Materials"; and "Mechanical Equipment."

Second: Each of these three groups are divided into as many sub-divisions as necessary (ten being used in the outline shown).

Third: Each sub-division is divided into sections, and each section is given over to catalogs illustrating the same articles of manufacture.

The method used to indicate these various sections is shown in the accompanying illustration: Consider the outline. "Plant" comprises a group known to contractors as equipment or materials needed and used in engineering and construction work but which do not become a part of the completed structure. To "plant" are assigned catalogs from numbers 1,000 to 2,000. Under "plant," for instance, we find "Excavating and Foundation Equipment" (the first used equipment and the first sub-division), to which are assigned catalogs from numbers 1,100 to 1,200. "Excavating and Foun-

OUTLINE OF CATALOG FILING SYSTEM

PLANT—1,000 TO 2,000

Excavating and Foundation Equipment		1,100 to 1,200
Excavators	1,110 to 1,120	
Derricks and pile drivers	1,120 to 1,130	
Pumps and air compressors	1,130 to 1,140	
Cars and scrapers	1,140 to 1,150	
Loaders and unloaders	1,150 to 1,160	
Future sections	1,160 to 1,200	
Forms and Form Equipment		1,200 to 1,300
Column forms	1,210 to 1,220	
Tank forms	1,220 to 1,230	
Miscellaneous forms	1,230 to 1,240	
Form clamps	1,240 to 1,250	
Future sections	1,250 to 1,300	
Concrete Handling Equipment		1,300 to 1,400
Mixers	1,310 to 1,320	
Towers and spouting equipment	1,320 to 1,330	
Hoists	1,330 to 1,340	
Engines and boilers	1,340 to 1,350	
Bins and buckets	1,350 to 1,360	
Screens and gravel washers	1,360 to 1,370	
Future sections	1,370 to 1,400	
Small tools		1,400 to 1,500
Barrows and buggies	1,410 to 1,420	
Bar benders and cutters	1,420 to 1,430	
Saws and power tools	1,430 to 1,440	
Lights	1,440 to 1,450	
Finishing machines	1,450 to 1,460	
Painting machines	1,460 to 1,470	
Jacks and miscellaneous tools	1,470 to 1,480	
Specialties	1,480 to 1,490	
Future section	1,490 to 1,500	
Engineering Supplies		1,500 to 1,600
Instruments—Field and office	1,510 to 1,520	
Books	1,520 to 1,530	
Testing instruments	1,530 to 1,540	
Future sections	1,540 to 1,600	
Future Sub-Divisions		1,600 to 2,000

BUILDING MATERIAL — 2,000 TO 3,000

Concrete Work		2,100 to 2,200
Sheet piling and piles	2,110 to 2,120	
Waterproofing and damp-proofing	2,120 to 2,130	
Reinforcing systems	2,130 to 2,140	
Inserts and anchors	2,140 to 2,150	
Curb bars, etc	2,150 to 2,160	
Future sections	2,160 to 2,200	
Masonry Work		2,200 to 2,300
Brick	2,210 to 2,220	
Hollow tile	2,220 to 2,230	
Stone	2,230 to 2,240	
Cements and mortar ingredients	2,240 to 2,250	
Plasters and plaster boards	2,250 to 2,260	
Future sections	2,260 to 2,300	
Roofing and sheet metal work		2,300 to 2,400
Cement, slate and tile	2,310 to 2,320	
Prepared roofing	2,320 to 2,330	
Ventilators and skylights	2,330 to 2,340	
Coping and flashing blocks	2,340 to 2,350	
Future sections	2,350 to 2,400	
Flooring		2,400 to 2,500
Cement floors	2,410 to 2,420	
Hardeners	2,420 to 2,430	
Wood floors	2,430 to 2,440	
Tile floors	2,440 to 2,450	
Mastic floors	2,450 to 2,460	
Composition floors	2,460 to 2,470	
Future sections	2,470 to 2,500	
Sash and Doors		2,500 to 2,600
Hollow metal and metal covered sash	2,510 to 2,520	
Steel sash	2,520 to 2,530	
Sash operators	4,530 to 2,540	
Glass and glazing	2,540 to 2,550	
Hollow metal and metal covered doors	2,550 to 2,560	
Rolling shutters	2,560 to 2,570	
Finish hardware	2,570 to 2,580	
Store fronts	2,580 to 2,590	
Weather strips, etc	2,590 to 2,600	
Screens and screening material	2,590.0 to 2,590.10	
Miscellaneous Iron and Steel		2,600 to 2,700
Stairs and fire escapes	2,610 to 2,620	
Grilles and gratings	2,620 to 2,630	
Iron covers, doors and frames	2,630 to 2,640	
Partitions and fences	2,640 to 2,650	
Steel buildings	2,650 to 2,660	
Structural steel	2,660 to 4,670	
Masons' specialties	2,670 to 2,680	
Future sections	2,680 to 2,700	
Decorative Materials		2,700 to 2,800
Paints, stains and varnishes	2,710 to 2,720	
Ornamental tile	2,720 to 2,730	
Architectural terra cotta	2,730 to 2,740	
Bronze tablets	2,740 to 2,750	
Wrought iron work	2,750 to 2,760	
Future sections	2,760 to 2,800	
Future Sub-Divisions		2,800 to 3,000

MECHANICAL EQUIPMENT—3,000 TO 4,000

Sanitary Equipment		3,100 to 3,200
Pipe and fittings	3,110 to 3,120	
Plumbing fixtures and drains	3,120 to 3,130	
Sewage disposal equipment	3,130 to 3,140	
Water supply systems	3,140 to 3,150	
Future sections	3,150 to 3,200	
Heating and Ventilating Equipment		3,200 to 3,300
Pipe and fittings	3,210 to 3,220	
Boilers and radiation	3,220 to 3,230	
Ventilating and air conditioning equipment	3,230 to 3,240	
Heat regulating equipment	3,240 to 3,250	
Future sections	3,250 to 3,300	
Electrical Equipment		3,300 to 3,400
Wiring materials	3,310 to 3,320	
Lighting fixtures	3,320 to 3,330	
Clock systems	3,330 to 3,340	
Motors	3,340 to 3,350	
Future sections	3,350 to 3,400	
Elevating and Conveying Equipment		3,400 to 3,500
Elevators	3,410 to 3,420	
Elevator appliances	3,420 to 3,430	
Mechanical conveyors and hoists	3,430 to 3,440	
Bucket conveyors	3,440 to 3,450	
Gravity conveyors and chutes	3,450 to 3,460	
Cableways	3,460 to 3,470	
Future sections	3,470 to 3,500	
Power Plant Equipment		3,500 to 3,600
Boiler equipment and boilers	3,510 to 3,520	
Chimneys	3,520 to 3,530	
Oil and gas burning equipment	3,530 to 3,540	
Coal handling equipment	3,540 to 3,550	
Ash conveyors	3,550 to 3,560	
Power transmission	3,560 to 3,570	
Future sections	3,570 to 3,600	
Oil Handling Equipment		3,600 to 3,700
Oil well equipment	3,610 to 3,620	
Oil meters and measuring devices	3,620 to 3,630	
Gas and oil tanks and pumps	3,630 to 3,640	
Oil filters	3,640 to 3,650	
Future sections	3,650 to 3,700	
Warehouse and Storage Equipment		3,700 to 3,800
Refrigerating apparatus	3,710 to 3,720	
Insulation materials	3,720 to 3,730	
Rug cleaning equipment	3,730 to 3,740	
Hand and power trucks	3,740 to 3,750	
Piling and stacking machines	3,750 to 3,760	
Future sections	3,760 to 3,800	
Miscellaneous Equipment		3,800 to 3,900
Sprinklers and sprinkler equipment	3,810 to 3,820	
Vacuum cleaners	3,820 to 3,830	
Foundry equipment	3,830 to 3,840	
Fire fighting apparatus	3,840 to 3,850	
Awnings, shades, etc	3,850 to 3,860	
Future sections	3,860 to 3,900	
Future Sub-Division		3,900 to 4,000

dation Equipment" is comprised of its appropriate sections, the first being "Excavators," catalog numbers 1,110 to 1,120.

Thus, to find a catalog on "Erie" excavators, it is recognized immediately that it will be found in the section given over to "Excavators," sub-division "Excavating and Foundation Equipment," and that portion of the file carrying catalog on "Plant."

The same principle holds true throughout and familiarity with the general scheme means, no time lost in referring to an index. Expansion can be carried to any desired limit by the simple expedient of carrying the catalog numbers into decimals.

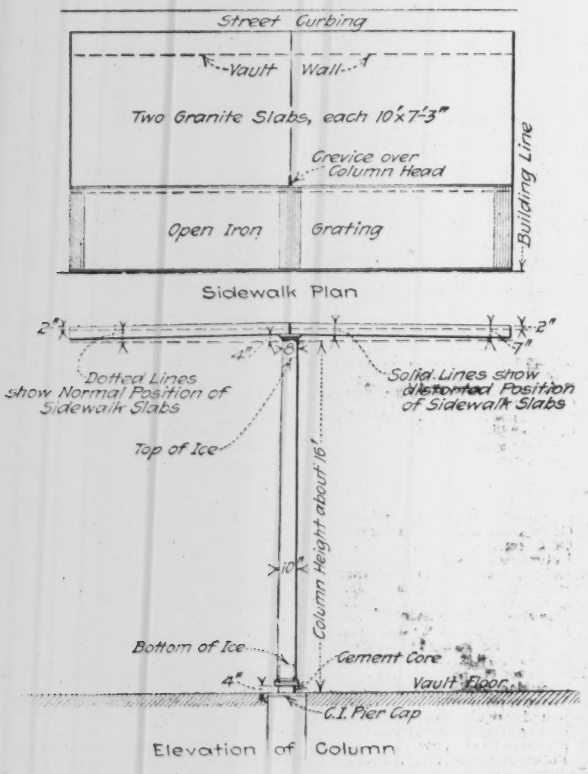
Ice Inside Cast-Iron Column Raises Floor

BY CHARLES BALDERSTON
Architect, Philadelphia, Pa.

DURING the past winter the writer had called to his attention a case of ice formation inside a cast-iron column which resulted in lifting the column several inches off its base and pushing up a heavy granite sidewalk a like distance.

The column is located in a vault under a sidewalk and carries the inner sides of two 10 x 7-ft. granite slabs about 7 in. thick. There is a joint between the slabs in line with center of the column head, and water had trickled in this joint at a point directly over the column where the cement had dropped out. The column has no cap nor integral base plate, but rests upon a cast-iron pier cap on the masonry foundation. The bottom of the column has a core of concrete about 15 in. high, making a water seal. Extending the entire front of the building, there is an open iron grating about 4 ft. in width, the outer edge of this grating being carried on the inner edge of the granite slabs. Consequently the vault under the sidewalk is exposed to the outside temperature.

When the writer saw the column it had been lifted 4 in. above the iron pier cap and the superimposed work had been correspondingly lifted. Exploration with an auger through the crevice between the granite slabs over the column head proved the presence of the ice. This was removed by drilling a hole just above top of cement core and then heating the column. With this relief the column and sidewalk gradually settled down to normal positions. After this the granite was jacked up a little and a lead capping was put on the column; there was no easy way to pour in concrete for filling the column to its top, or that would have been the alternative treatment. It should be remarked that the column has an entasis, being 10 in. diameter at bottom and about 8 in. at top, which doubtless contributed to lifting power of the ice.



CAST-IRON COLUMN WHICH FILLED WITH ICE

A 900-In. Rain Gage on a Peak of Kauai

WHAT appears to be the largest rain gage in existence has recently been installed in one of the Hawaiian Islands. John C. Hoyt, Chief, Division of Surface Waters, United States Geological Survey, has written to *Engineering News-Record* regarding this gage as follows:

"I have just returned from the Hawaiian Islands and while there visited the general location of this gage, which is on Mount Waialeale, a peak on the Island of Kauai. As stated on p. 303 of the *Monthly Weather Review* for May, 199, there is probably no place in the world where there is a greater rainfall than at this point. The new gage, which was recently installed by the Water Resources Branch of the United States Geological Survey in co-operation with the Public Lands Department, T. H., has a capacity of 900 in. and consists of a copper receptacle of sufficient size to hold that amount of water falling on an opening of 6 in. in diameter. The gage, which was previously located at this point, had a capacity of 500 in. and was not sufficient to take care of a year's rainfall. On account of the difficulty in visiting the gage only one or two visits can be made to it a year. It is specially interesting to know that within 15 miles of this point the rainfall is less than 20 in. This extreme variation is a common characteristic of change in climatic conditions in various parts of the Hawaiian Islands."

Meters and Low Water Consumption

St. Paul, Minn., has 97.6 per cent of its domestic and industrial water consumption metered, but as many commercial users are not metered the percentage of total consumption that passes through meters is only 62.8 per cent. The daily consumption is 63 gal. per inhabitant, 76.4 gal. for each person supplied and 424 gal. per tap. The cost of supplying water per million gallons, figured on maintenance, is $40.01. Adding bond interest and sinking fund the cost is $70.83. The St. Paul waterworks supplies only 60 per cent of the total water used within the area served, the remainder of the supply, mostly large consumers, being from artesian wells owned by the consumers.

Precast Concrete Slabs for Small Irrigation Structures

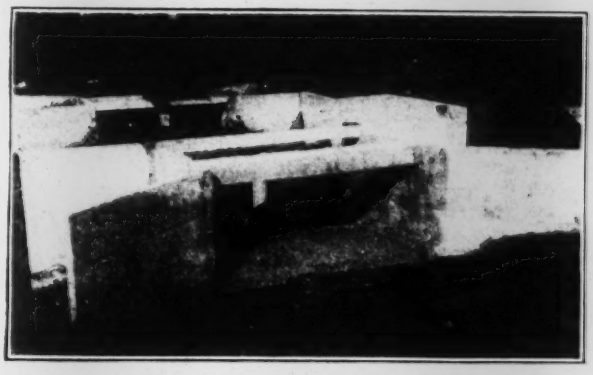
"Concrete Lumber" Being Used on Several California Districts Has Many Advantages Over Redwood—Cost Is About the Same

By Roger W. Olmsted
San Francisco, Cal.

REINFORCED concrete precast in thin slabs and popularly known as "concrete lumber" is now being used for constructing gates, checks, drops, etc., in several irrigation districts in California. The South San Joaquin Irrigation District has begun the replacement of about 3,000 irrigation structures with precast slabs and at current prices their cost is about the same as it would be for redwood which is ordinarily used. The idea was developed in this district, but a commercial organization has recently been formed to contract for making the slabs on other districts. Control of the system is retained by means of patent covering the design of the joints.

Despite the name "concrete lumber" no nails or bolts are used in the assembly of the structures. The bond between slabs is obtained by beveled lugs on ends and sides which fit into corresponding recesses in the adjoining labs. Beams are used as spreaders. The structures are designed so that joints between slabs will come where the bending moment is least, thus requiring the lugs to resist shear only. The ordinary joints will not resist tension, although one form of dovetailed tension joint has been used successfully where tensions between slabs could not otherwise be taken care of. The shape of the lugs and the location of the reinforcing steel within has been worked out, by calculation and test, so as to develop the maximum strength at the joints.

The structures on the South San Joaquin Irrigation District which are now being replaced with concrete lumber are to handle from 20 to 45 sec.-ft. and have net openings ranging from 2½ x 6 ft. to 3 x 12 ft. The wooden service gates contain 600 ft. board measure and the check gates 925 ft. board measure, No. 1 common redwood. These wooden structures were built early in 1914 and after six years of use many require replacement on account of decay. The new concrete slab gates are of approximately the same dimensions, having a total surface area of between 220 and 300 sq.ft.



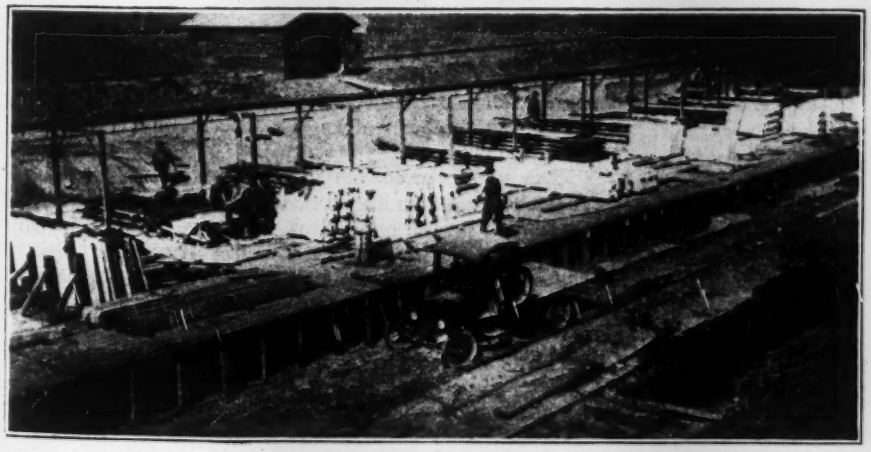
TYPE OF IRRIGATION STRUCTURE BUILT OF CONCRETE LUMBER

To make the slabs for these structures, the district established a casting yard in a gravel pit at a convenient location where there was an amply supply of very clean and well-graded sand in bank formation carrying sufficient rock up to 1 in. in diameter to make good concrete. The yard is served by a railroad spur and is so laid out that the casting platform is at a lower level than the railroad track and the gravel supply. The motor trucks which carry away the slabs load on a depressed roadway so that the truck bed and casting platform are on the same level. The platform is 50 x 100 ft. in plan and has an overhead crane rail for its entire length on which a chain block is used for handling forms and slabs.

It was found that the requirements of the district could be met by four standard types of structures. Slabs of various sizes and shapes were required but it was found possible to standardize certain features, for example, all slabs are made 2 in. thick and the spacing of the lugs is uniformly 6 in. The two largest sizes of slabs are 2 x 8 ft. and 4 x 6 ft. respectively.

The lugs are all 6 in. long by 2½ in. wide. The beveled face is 22½ deg. from the line normal to the plane of the slab. At first a 45-deg. slope was used, but after some experiences with the slabs this was decreased to 22½ deg. It is now thought that this is not sufficient, and a series of laboratory tests are to be carried out to determine the best slope and also the most advantageous position of reinforcing. At present the reinforcing for the lugs is bent by hand around some conveniently arranged bolts in a wooden form built up for the purpose. The lug reinforcing wires are only long enough to go once around the outer edge of the lug for which they are made and to leave two ends long enough to give a bond in the concrete of the slab itself.

The concrete is poured onto 5 x 20-ft. trays, built up of 2 x 12-in. surfaced lumber and well oiled. The various sizes and shapes of slabs are outlined on these trays with 2 x 2-in. strips. The trays are stacked five high with reinforcing in place and a sixth tray is arranged ready for



CASTING PLATFORM FOR CONCRETE LUMBER

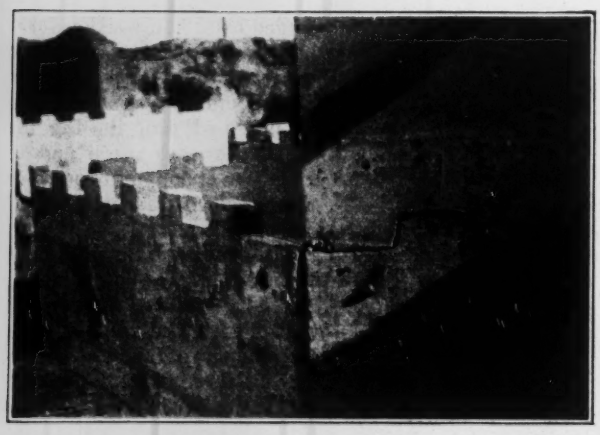
FILLING THE TRAY FORMS AS THEY ARE STACKED

pouring on the platform beside the stack. Thus, when this tray on the platform has been poured, another tray can be quickly set on top of it from the stack that stands waiting and the concrete can be poured practically continuously.

The first reinforcing used was 3 x 16-in. galvanized mesh of No. 6 and No. 10 wire, respectively. This was found to be insufficient to take care of handling stresses, particularly in the wide slabs. The reinforcing was therefore changed to a 6 x 6-in. mesh, all of No. 6 wire. This, with a light top reinforcing, was found to be sufficient to take care of the working strains as well as those ordinarily developed in handling. The handling stresses are often very severe and slabs are occasionally cracked, but it is thought better economy to lose an occasional slab than to attempt double reinforcing on all slabs.

The forms are designed so that the slab is cast with the finished face downward. The reinforcing rests on the bottom of the tray but is worked upward immediately after pouring just enough so that the reinforcing will not show through the face of the concrete. The cracks due to stresses incurred in handling are usually on the compression side of the slab and very often these in no wise destroy the value of the slab. Some which were cracked in this way were used just as originally intended and are giving satisfactory service.

The crew in the casting yard consists of seven men for an output of 20 gates per week. Each gate contains from 17 to 20 pieces, in the latter case there are 16 slabs, 2 beams and 2 center posts. A motor truck with driver and one helper for loading and unloading delivers from casting yard to the point of installation an average of three structures per day where the haul does not exceed six miles.

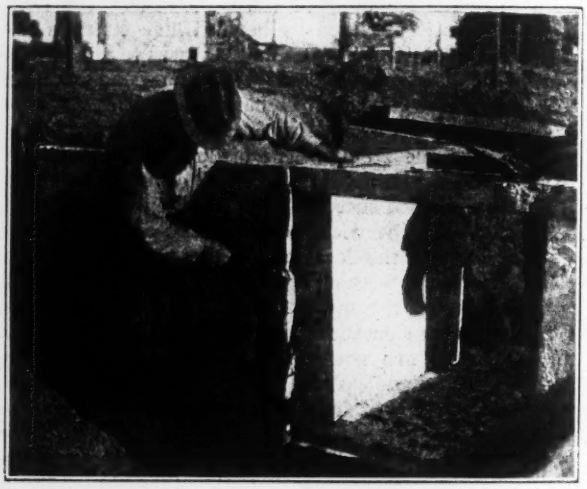


HORIZONTAL JOINTS IN VERTICAL SLAB WALLS

The erection crew consisting of four men is ordinarily able to make excavation for and erect two structures per day. A few structures have been erected by two men, but this requires the exercise of some ingenuity as it is necessary to handle slabs weighing 600 lb. The wedge fit on the lugs brings the joints together tightly so that but little grout is required to take up the play and make the structure water-tight. Wooden grooved boards are bolted to the face of the structure to receive the removable wooden flash boards.

Of the 120 structures that have thus far been set, three were partially washed out, due to careless back-filling. However, this did not damage the individual slabs in any way and they were simply reset, re-joined and the structure rebuilt exactly as it was before except that the back-fills were properly puddled in place. This illustrates an advantage which the precast slab structure has over the monolithic type.

In the Corduf Irrigation District a casting yard was laid out and slabs were poured before any of the ditch excavation was begun, thus the structures were completed and in the field before the earthwork was finished. A total of 105 structures averaging about 160 sq.ft. of surface area each were cast in sixty working days, including organization and the laying out of the casting yard. The majority of these structures were delivered along the ditches before the last of the casting had been completed.



GROUTING A VERTICAL JOINT IN CONCRETE LUMBER STRUCTURE

The saving in cost of the precast gate over the cost of monolithic structures varies from 25 to 40 per cent, depending on the number of structures and local conditions. In the South San Joaquin Irrigation District the service gates containing 220 sq.ft. of surface area are installed complete for approximately $75 and the check structures containing 280 sq.ft. for $95, all lumber included. Reduced to a yardage basis, this is equivalent to concrete at $50 per cu.yd. The amount of concrete per slab gate is only from one-third to one-half that of the monolithic structure.

Facts on Federal-Aid Road Work

IN THE examination of witnesses appearing before the Senate Committee on Post Offices and Post Roads in connection with the hearings upon the several highway bills which have been presented to Congress, some illuminating data were incorporated in the testimony of M. O. Eldridge, for many years with the Bureau of Public Roads and now director of road activities for the American Automobile Association. In his studies as to the use to which the various states put Federal-aid funds, Mr. Eldridge finds that 34 states are using Federal aid for exclusive use upon state systems and 14 are not. Twenty states apply their Federal-aid money to durable types of construction and 17 do not. Nine other states use most of their Federal-aid funds for durable paving. Only 17 states apply Federal-aid allotments exclusively to designated state systems and to durable types of construction. These states are Arkansas, Illinois, Indiana, Kansas, Maine, Maryland, Michigan, Montana, New Hampshire, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, Rhode Island, Vermont, and Washington.

The following table shows the average cost per mile, by types, of Federal-aid projects executed to date, as reported by Mr. Eldridge:

AVERAGE COST, BY TYPES, OF FEDERAL-AID PROJECTS EXECUTED DURING FISCAL YEARS 1917, 1918 AND 1919, AND FIRST QUARTER 1920

Type	Mileage Approved	Per Cent of Total	Total Cost	Average Cost per Mile
Earth	2,003.61	26.7	$8,662,794.52	$4,324
Sand-clay	670.41	8.9	2,840,147.90	4,236
Gravel	2,112.20	28.1	13,717,562.96	6,494
Macadam	190.48	2.5	2,281,917.24	11,980
Macadam, mat top	170.08	2.2	1,275,712.95	7,501
Bituminous macadam	192.42	2.6	4,593,953.27	23,875
Bituminous concrete	141.79	1.9	3,530,686.46	24,901
Concrete	925.58	12.3	29,757,483.78	32,150
Brick	110.12	1.5	4,731,227.11	42,964
Miscellaneous	37.79	0.5	189,614.53	5,108
Undetermined	963.65	12.8	13,362,947.15	15,942
Total	7,518.13	....	$84,035,045.00	....

Of the miles of Federal-aid projects approved to Sept. 30, 1919, 4,877 mi., or 66 per cent, of the total (7,518 mi.), are roads of the less durable types, namely, earth, sand-clay, gravel, and macadam, suitable for light traffic only. These roads will cost $27,502,421, which is about 33 per cent of the total ($84,035,045) cost of projects executed to the end of the first quarter, 1920.

STATES USING FEDERAL AID ON THE LESS DURABLE TYPES

	Earth, Per Cent	Gravel, Per Cent	Sand-clay, Per Cent	Total, Per Cent
Alabama	....	34.6	58.1	92.7
Florida	....	....	61	61
Georgia	6	....	91	97
Idaho	90.1	9.1	....	100
Iowa	66	21.5	....	87.5
Louisiana	2.1	95.5	....	97.6
Minnesota	16	76	....	92
Mississippi	18	79	....	97
Missouri	....	73	....	73
Montana	....	100	....	100
Nebraska	76	4	1	81
Nevada	29	58	....	87
North Carolina	18	8	45	71
North Dakota	84	10	1	95
South Carolina	4	3	47	54
South Dakota	25	75	....	100
Utah	52	....	....	52
Wyoming	47.6	31.1	....	78.7

The distribution, by states, of less durable types built by Federal-aid is given in the above table.

Springfield Relief Sewers: A Correction

By a typographical error the estimates for the cost of relief sewers at Springfield, Mass., printed on p. 1055 of our issue of May 27, were given as based on 1909 instead of 1919 prices.

Notes from Foreign Fields

LONDON AFTER FOUR DAYS

BY

E. J. McHenry

EDITOR ENGINEERING NEWS-RECORD

IT takes a brave man, indeed, to attempt to write impressions of such a city as London after an acquaintance of only four days. Still, one does have impressions which, with suitable reservations, may be of interest, if not of value.

Of one thing I can already speak positively: I had been warned that one could not do business as speedily here as in the States, and that our English friends would probably be uncommunicative—difficult to "draw out." My experience has been quite the contrary. There has been rare courtesy—of a kind that we are largely strangers to; there has been the utmost frankness; there has been a desire to expedite appointments due to an evident appreciation that a man from overseas is limited as to time. Everyone to whom I have gone, with or without letters of introduction, has done his utmost to help.

Much to my surprise, London does not impress me as a foreign or a strange city. It reminds me of Boston. I have found two Americans and two Englishmen who have been similarly impressed. The resemblance lies not merely in the buildings and in the narrowness and crookedness of the streets, but in the atmosphere of the two cities as well. Arthur J. Martin, the well-known sanitary engineer who, with Dr. Soper and Mr. Watson, of Birmingham, England, reported on the Chicago sewerage problem some years ago, said to me yesterday that he did not feel at home in America until he went to Boston. He longed for a crooked street while in New York, but was able to find only partial relief by walking along the sinusoidal paths of Riverside Drive.

So far, two engineering features have impressed me particularly in London: the pavements and the buses. I have seen only the pavements in the business section of London, in the "City" and in Westminster. They are in very good condition, despite the fact that they carry a dense traffic, with a large proportion of heavy vehicles. Without having traffic counts before me I should hazard the statement that the truck and bus loads represent a larger volume of really heavy traffic than we have in any of our cities. In spots Detroit and Cleveland may have heavier average loads, but here heavy loads are found everywhere. The steam lorries, too, generally pull one trailer. The double-deck motor buses are heavy affairs and travel, except in severe congestion, between 15 and 20 miles per hour.

The other feature that has impressed me so strongly is the motor bus transportation. Buses run everywhere, some runs, I am told, being as long as 25 miles. They seem to furnish a satisfactory mode of transportation for relatively short runs. Despite the rise in all costs here, the minimum charge for bus rides is only one penny, or 2 cents in our money. That is true of the "Underground" as well. All fares are on the zone system, the rates running one penny per mile. At this rate, however, both the buses and the Underground, so a dis-

interested authority tells me, are losing money. Efforts are being made by the utility company to secure an increase of rates. The municipal tramways, owned and operated by the London County Council, are likewise losing money; that is, they are earning operating expenses and interest, but will this year probably not be able to put the proper amount into their sinking fund.

In the field of construction, conditions resemble those in the States. Indeed, my first impression is that conditions are actually worse here. Wages and materials are at abnormal levels, and have prevented the extensive resumption of construction. There is no large amount of railroad or public work under way, except housing. In the latter field there are tremendous schemes, regarding which I propose to write later. Private work, too, is discouraged by the high prices, and is now still further subject to curtailment by the power of the Ministry of Health to prevent "luxury" construction. This restrictive power has already been commented on in *Engineering News-Record*.

It is evident that labor here is entirely out of hand. The leaders have lost control over the men; radical counsel prevails. Restriction of output, of which many examples have been given me, is evidently worse than it is in the States. Prices continue to rise, and here as well as at home there is a feeling that a crash is bound to come.

London, May 8, 1920

Engineers in Westminster Abbey

Until yesterday I did not know that there was in Westminster Abbey a well-defined location for the tombs and monuments of scientists and engineers. We all know of Poets' Corner and of the Royal Chapels which contain the bones of many of England's kings and queens, but the engineers' and scientists' corner (an inadequate description for one spot in the quiet nave and in the north aisle) has not been celebrated in the descriptions of the Abbey that have come to my hand. Consequently I was the happier at the discovery.

Against the screen of the choir stalls, looking into the nave, is the monument of Sir Isaac Newton, while directly in front, well out in the center of the nave, are the tombs, under the pavement, of Telford and George Stephenson, Telford's marked by one of the small square pavement stones cut with his name and Stephenson's by a full length floor panel—a work of art in bronze. A statue of Telford stands elsewhere in the Abbey. What a fitting home for the long sleep of these master engineers! Above them springs the wonderful Gothic nave, airy in its lightness, yet built of stone—a sight such as I have never seen. The master builders of a later age lie asleep beneath the work of the master builders of all time, masters who outrivalled those of ancient Egypt, or Greece or Rome—the Gothic cathedral builders of the Thirteenth Century. Egypt built great temples and mighty pyramids; so did Greece and Rome. But structurally the forms were simple. With the high-flung naves and crossings and choirs of the Middle Ages came engineering problems of no mean order. Yet so well were the principles understood that wonderful grace and appearance of lightness were secured. Today, with all our advances, we do nothing to equal their master works.

But to return to the engineers in Westminster: By the side of Newton, directly in front of the New[ton] monument, lies the body of the late Lord Kelvin, wh[ile] 20 ft. to the north, in the aisle, lie, side by side, t[he] bodies of Herschel, the astronomer, and of Charl[es] Darwin. Above these vaults, casting on them a ligh[t] mellowed by the art of the stained-glass worker, ar[e] a memorial window to Sir Benjamin Baker, the i[n]scription recording two of his great works—the Forth Bridge and the Assuan Dam—and another to Lord Kelvin, "Engineer and Natural Philosopher," as the inscription has it. In this same north aisle are memorial windows, also, to Stephenson, Joseph Locke, designer of the Crewe engine; Brunel, Trevithick, and Charles William Siemens.

The Siemens window looks down on a group of tablets to scientists—to Lister, the physician; Darwin, Hooker, the botanist; Adams, the astronomer, and Joule, the physicist. The Joule tablet bears this inscription: "This tablet is here placed near the graves of Newton, Herschel and Darwin by those who in many lands have united to perpetuate the memory of James Prescott Joule, F.R.S., of Manchester, in recognition of services rendered to science in establishing the law of the conservation of energy and determining the mechanical equivalent of heat."

In the central part of the nave and the north aisle are buried other great men with kinship to engineers. We find the tomb of Sir Charles Lyall, the geologist. It is covered by a brass-lettered slab bearing this tribute: "Throughout a long life he sought the means of deciphering the fragmentary records of the earth's history, in the patient investigation of the present order of nature, enlarging the present boundaries of knowledge and leaving on scientific thought an enduring influence." Out in the center of the nave, near the graves of Telford and Stephenson, are four graves placed with singular appropriateness under this great nave—mortal remains of four architects who played an important part in the revival of Gothic architecture. They are Sir Charles Barry, architect of the Houses of Parliament; Sir George Gilbert Scott, George Edmund Street and John Loughborough Pearson.

As I turned to leave this part of the Abbey, after musing there an hour, I chanced to walk over the Telford inscription and my eye caught on the slab at Telford's feet the name of Livingstone—David Livingstone, the African explorer—and the thought struck me that he was in kindred company. He explored an unknown country; he extended the bounds of knowledge regarding a section of the earth's surface. So did Telford and Stephenson and Lyall explore the unknown; so did they, and their great fellow engineers and scientists about them, extend the bounds of knowledge. They, no less than he, were explorers of a dark continent and have placed humanity under tribute for all time.

London, May 9, 1920.

City Zoning at Dallas, Texas

Work is being done preliminary to the establishment of a zoning system for Dallas, Tex. Much of the information necessary for use in dividing the city into industrial and residential districts has been gathered. Robert H. Whitten, city plan consultant, Cleveland, Ohio, has been retained to assist in the work.

Henderson Liftable Bridge Plan for Pittsburgh

Proposed for Rebuilding of Sixth, Seventh, and Ninth Street Bridges—Large Saving in Approach Grades

AN ORDER of the War Department requires the Allegheny River bridges at Pittsburgh to be altered or reconstructed to give a clearance height of 33 ft. above flood level (the latter taken as 14 ft. above pool level). Under this order, which also prescribes certain span lengths, as noted in *Engineering News* of March 29, 1917, p. 533, plans are now being prepared for the rebuilding of the bridges at 16th St. (destroyed by fire some months ago) and 43d St. Following this work, the large downtown bridges at 6th, 7th, and 9th Sts. must be rebuilt, the last to be started within little more than a year from the present time. In view of the serious inconveniences resulting from the necessity for providing long approach grades to suit the greatly increased elevation of the bridges under the War Department order, the planning of the downtown bridges constitutes a difficult problem. A wholly new solution is suggested in a proposal recently made by A. A. Henderson, assistant county engineer of Allegheny County. He proposes that the river spans be arranged so that they can be adjusted in vertical position to suit the water stage, being kept ordinarily at proper clearance height above pool level, and raised in flood time to maintain the clearance. Apart from the novelty of the proposal, its service value entitles it to attention. Long approach grades would be done away with, as the approaches would be adjusted to the low-water position of the bridge. During high water the gradients would be steeper, but traffic would not be materially inconvenienced because the condition would be maintained for only a short time.

A diagrammatic sketch of the proposed arrangement is shown in Fig. 1 herewith. The structural and mechanical nature of the proposed arrangement will be sufficiently evident from the sketch to require no further explanation. It should be borne in mind that the raising of the structure, while involving very great weight, would need to proceed at only an extremely slow rate, and in any event would be an infrequent operation, so that the type and construction of the raising machinery would be likely to differ fundamentally from that applied to ordinary lift bridges.

Mr. Henderson says: "The hydraulic lift, though possibly not the cheapest method, will apparently be the most effective and satisfactory. Other means may be employed if desired." And concerning the necessity for providing attendants to operate the machinery, he remarks: "The necessity for employing operators for a movable bridge should not be considered as introducing a new feature in the maintenance of the bridges. At present the bridges are under constant supervision of persons employed for that special purpose, and this practice will doubtless be continued in respect to the new bridges, regardless of the type erected. By judicious selection and a proper assignment of duties, the attendants can, without large increase of number, be rendered able to handle the operation of the lift."

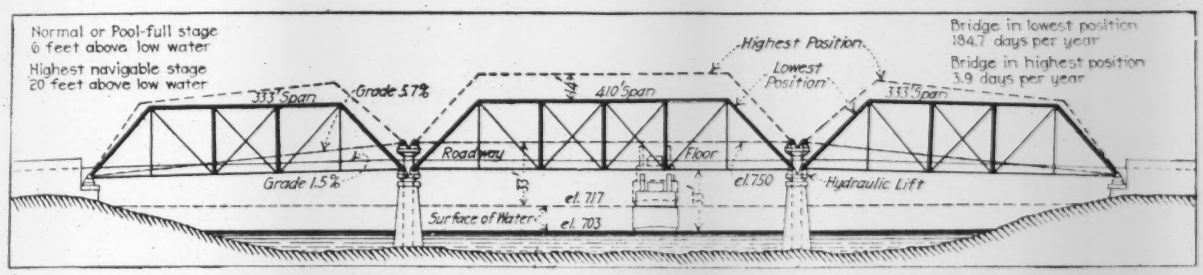


FIG. 1. DIAGRAM OF HENDERSON LIFTABLE SPAN ARRANGEMENT PROPOSED FOR ALLEGHENY RIVER BRIDGES. SPANS FOR SIXTH STREET LOCATION

(Elevation 703 is normal water level or pool-full stage, which is 6 ft. above low water)

In the curve plot Fig. 2, prepared by Mr. Henderson, is represented the condition as to variation of water height in the Allegheny River. From this it is clearly apparent that if the permanent position of the bridges must be fixed to suit the 20-ft. stage, traffic will have to overcome a useless rise and fall averaging 28 ft. If, as was agreed by the city and county authorities in discussions of the subject several years ago, the approach grade should be not steeper than 3 per cent, the 14-ft. difference in elevation involves extra approach lengths of several hundred feet each on either side of the Allegheny river.

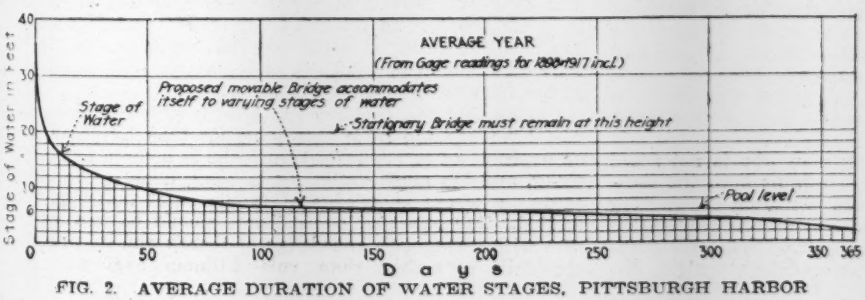


FIG. 2. AVERAGE DURATION OF WATER STAGES, PITTSBURGH HARBOR

Centrifuge Tests at Milwaukee Sewage Station

A Te Meer centrifuge is to be installed at the Milwaukee sewage testing station for the purpose of demonstrating its capacity for dewatering activated sludge. The machine is an improvement of the Schaeffer Te Meer centrifuge and is a new type of the machine now being used at Hanover and Frankfort, Germany. It is expected that the Barth Manufacturing Co., New York City, will deliver the new machine at Milwaukee in August. T. Chalkley Hatton is chief engineer, Metropolitan Sewerage Commission.

LETTERS TO THE EDITOR

Shenehon for Joint Commission

Sir—In regard to item in your issue of May 27th under the heading, "Urge Appointment of Shenehon," I wish to say that the movement to have Francis C. Shenehon of Minneapolis appointed on the International Joint Commission was inaugurated by the Minnesota Joint Engineering Board. They secured the endorsement of Mr. Shenehon by the Minneapolis Civic and Commerce Association and by the St. Paul Association of Public and Business Affairs. They also secured a strong editorial favoring the appointment in the Minneapolis papers and a very favorable endorsement editorially by the St. Paul papers.

The Board's efforts at Washington were taken up through the Engineering Council and its Washington office, and later through their Senators and Representatives. Endorsements of the business associations being sent direct to Secretary Tumulty.

St. Paul GEORGE H. HERROLD,
Secretary-Treasurer, Minnesota Joint Engineering Board.

Progress of the Co-operative System of Engineering Education

Sir—In *Engineering News-Record* of April 8, p. 698, you had two editorial notes entitled "Progress of the Co-operative System" and "Stubborn Criticism." I agree with you most heartily in your endorsement of the co-operative principle in engineering education.

I first encountered co-operative students from the University of Cincinnati in the great Miami Valley immediately following the 1913 flood. Two of these young men were working in a bridge gang. They were "putting in" the same number of hours, eating the same food, in short, experiencing the same living conditions as did the rest of the bridge gang. I have also seen these "co-ops" at work as inspectors, rodmen, chainmen and instrument men—as tracers, draftsmen and designers. In general, as "co-ops" they are good inside or outside men. I have seen a very high grade of design work carried to a successful conclusion by some of the more brilliant of these co-operative students. It is not exceptional that a pair of these "co-ops" receive as high as $150 to $200 a month for their services.

One of the best features of the system is that the average graduate is not only able to put himself through a five-year course without any debt, but he has about $200 savings in his pocket when he graduates. The University of Cincinnati has graduated a number of young engineers who put themselves through solely by their own earnings—young men who were sons of parents amply able to meet all expenses of the course. These young men were just as proud of having earned their own way through as were the young men who had no backing from home and were forced to earn their own education or never have it. Practical ability to solve the engineering problems in an accurate and expeditious style is chief among the assets of a young "co-op" graduate. Their theoretical education has been strengthened materially because they have been able to see just where the thoery fitted into the practice.

Upon graduation, the co-operative student has a definite practical value in the industrial market. His references are not confined to those from college professors vouching for his theoretical ability. He can show letters from the heads of industrial or engineering concerns. Those who have come in contact with the system and have given it a fair trial recognize that practically all young engineers who are the products of it become assets immediately upon graduation.

The system weeds out the young man who is not fitted for any kind of engineering, and it retains both the theoretical and practical student. There is not an engineering school in the country that has not made numerous mistakes in dismissing from its courses young men who are essentially practical engineers. The co-operative system discovers this young engineer and puts his practical ability on an equal plane with theoretical ability.

Certain conditions are absolutely essential to the carrying on of this type of course. Peculiarly gifted personality must be at the head of each co-operative department. These men must be able to meet, converse and co-operate intelligently with men of large business acumen. The educational institution proposing to start this system must have an industrial or engineering center nearby, otherwise students will not be able to acquire the practical end of engineering without excessive expense, due to transportation or living costs. It is necessary to have the co-operation of business concerns lying in the immediate vicinity of the school proposing this course.

There are a number of possible applications of this system which are interesting to observe. We are face to face today with a labor shortage. Statistics prove that we probably cannot count on immigration to solve this problem for us. The common laborer of today is insisting that his son shall not be the common laborer of tomorrow. This means that unless some scheme is devised we will gradually have fewer and fewer men willing to perform the more common tasks. Among the trades we find that the apprentice system is almost a thing of the past. The co-operative scheme can, I believe, go a long way toward filling these two gaps in industrial life. In other words, the scheme can be applied not only in the engineering field but to practically all other professional and trade fields. High schools are trying the scheme for some of their more purely industrial courses such as printing, woodturning and engraving. Industrial and business courses also have been started.

F. H. PLAISTED,
Office Engineer, C. C. C. & St. L. R.R.
Cincinnati, Ohio.

Insufficient Theory Dangerous in Structural Design

Sir—To my mind Mr. Godfrey's article, "A Call for a Practical View in Structural Teaching," in *Engineering News-Record* of May 13, 1920, emphasizes the need of a rational application of theory by the practical designer. No one but a rule-of-thumb designer with little or no knowledge of the fundamentals of mechanics would make the mistakes in design which Mr. Godfrey cites in his article.

The case of the twin columns shown in Fig. 2 illustrates very well the error which the man who is *not* well grounded in his theory will make. The "theorist" will immediately tell you that the bending moments in the two cases A and B are not equal. The bending caused by the 100,000-lb. load on top of column A will relieve some of the pressure on the ball and reduce the bending moment on the column. On the other hand the bending moment in column B will be increased by the deflection of the column under the 100,000-lb. load. The exact amount of these moments is very difficult of exact determination but an approximate solution can be worked out by assuming the bending due to the transverse load as the eccentricity of the direct load.

But even if the dimensions on the two sketches had been such as to produce equal bending moments in the two cases, the "theorist" would not pronounce the two columns of the same strength. Assuming the elastic limit of the material (which marks the ultimate strength in columns) to be 32,000 lb. per sq.in., Column A will carry an ultimate load of about 240,000 lb. while Column B will carry less than 130,000 lb. In other words, the "theorist" will tell you that the factor of safety on Column A is about twice that on Column B, although the maximum fiber stresses at the 100,000-lb. load may be nearly equal.

I think that Mr. Godfrey has been troubled by designers who have had too little theory rather than by those with an overdose of it. A little knowledge is often a dangerous thing, and too much designing is being done by handbook engineers whose knowledge of fundamental theory is very limited. The effort of our colleges should be to turn out men with a thorough knowledge of theory and its practical applications, rather than rule-of-thumb engineers who

depend upon handbooks for their theory. Mistakes in theory are not always absent in our handbooks, and a good designer must know his theory in order to use a handbook intelligently.

CLYDE T. MORRIS,
Professor of Structural Engineering,
Ohio State University.

Columbus.

Tonnage Maps for Railway Valuation

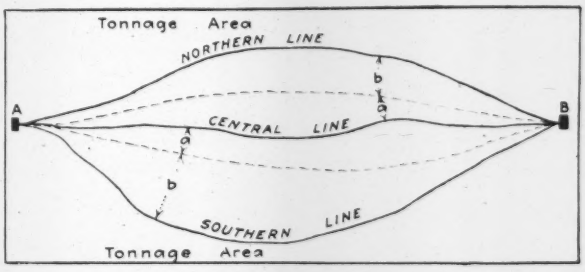
Sir—The Transportation Act, 1920, has revived the subject of railway values. The act although showing evidences of haste, which under the circumstances was unavoidable, is now the law. The immediate interest of engineers is concerned with its practical applications.

The market value of a railway property is based on its dividend earning capacity. These dividends are earned on the tonnage carried by the railways. Hence, the most important factor of value in estimating the market value of a railroad is the amount of tonnage that it controls.

This tonnage control produces certain common factors; i. e., in any given territory the competitive lines will average about the same operating standard, as falling below this common standard will result in a loss of through tonnage. The result is that regardless of the amount of tonnage contiguous to the main line, the through freight standard must be maintained, so that operating costs approximate a certain uniformity. These costs are further stabilized by the rates being fixed by the Interstate Commerce Commission, and the "blanket territory system" of rate making.

To ascertain the amount of tonnage controlled by any given railroad, a tonnage map must be compiled. A typical instance is illustrated by the accompanying drawing. In considering this situation no account will be taken of branch lines operated by the various companies, as these do not affect the general principle involved.

In compiling tonnage maps the unit is the county, and maps should be made to a scale of one mile to an inch. With such a county map, expert tonnage estimators would survey every square mile and assign to it its proper tonnage value. The next step would be to fix the lines of demarcation between the various railways and the variable



(a) and (b) distances, indicated in the drawing. At terminals, junctions, and connecting points, all available tonnage would be allocated to the proper company. In estimating available tonnage, a period of 20 years would be the limit for forecasting future conditions.

Considering the tonnage maps as completed, we have a basis to determine the value of a railway property in the following order:

(1) Amount of all tonnage controlled by the railway.

(2) Cost of construction, value of all property, equipment, etc.

(3) Amount of stocks, bonds, notes, issued against the company.

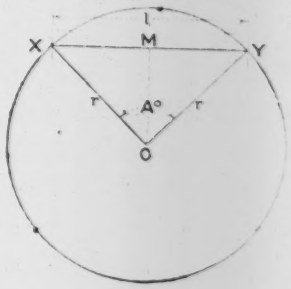
The one asset that a railway has is its tonnage resources, and until these can be determined, railway values can only be determined in an arbitrary manner. To merely take into account the cost of construction and equipment is an effort to balance expense ratios. The concrete fact of value can only be ascertained by an inventory of tonnage assets.

FRANK W. HARRIS.

Olympia, Wash.

Solution for Area of Segment of Circle

Sir—I wish to submit a solution for solving the area of a segment of a circle which is as accurate and easier than the one shown in the April 29 issue of *Engineering News-Record*.



In any segment you must know two of the following three things: Radius, r; long chord, l; and the angle at the center, A.

Area of the entire circle $= \pi r^2$

Area of the Sector $O\ X\ Y$ $= \pi r^2 \left(\frac{A}{360}\right)$

Area of the triangle $O\ X\ Y = XM \times OM$

$$= r^2 \sin \tfrac{1}{2} A \cos \tfrac{1}{2} A = r^2 \frac{\sin A}{2}$$

$$\pi r^2 \frac{A}{360} - \frac{r^2 \sin A}{2} = \frac{r^2}{2}\left(\frac{\pi A}{180} - \sin A\right) =$$

$$\text{Area} = \frac{r^2}{2}(.0174533\ A - \sin A)$$

I cannot tell where I got it, but have used it for over a year in calculating property areas.

JAMES R. MURRAY,
Civil Engineer.

Chicago.

Designing Double Reinforced Beams

Sir—In *Engineering News-Record*, April 29, p. 880, R. R Martel presented a method of designing reinforced-concrete beams with double reinforcement which is similar to a method used by the writer for the past twelve years or more.

With the same premises as used by Mr. Martel:

The unit fiber stresses and the ratio of moduli fix the position of the neutral axis at $0.378d$, from the top of the beam, and also the "percentage" of steel at $0.0077bd$.

The lever arm from the center of steel to the center of compression in the concrete is $d\ (1 - 0.378/3) = 0.874d$.

The area of steel required to resist 900,000 in. lb. moment is, $A = 900{,}000 \div 16{,}000 \times 0.874d = 3.06$ sq.in.

The tension in the steel is $3.06 \times 16{,}000 \ldots\ldots = 48{,}960$ lb.

The compression the beam is able to carry is

$0.378db\ 650/2 \ldots\ldots\ldots\ldots\ldots\ldots = 33{,}589$

Excess which must be taken by compression steel 15,371

By proportion, 7.95 : 650 :: 5.95 : 485.

485 lb. × 14 equals 6,790 lb. per square inch which the compression steel can carry. 15,370 lb. ÷ 6,790 lb. per square inch equals 2.26 sq.in. of compression steel.

If, instead of compression steel the beam is of T section, say a slab 5 in. thick is supported by the beam, their upper surfaces being at the same level, the design of the beam would be the same as that given above including the excess of 15,371 lb. tension over allowable compression. Now again by proportion 7.95 : 650 :: 2.95 : 241 lb. per square inch and the average compression in the wings of the T is the average of 650 and 241 or 445 lb. per square inch. As the slab is 5 in. thick, the compression per inch of wing width is 2,225 lb. and the total width of both wings is 15,371 ÷ 2,225 equals 6.9 say 7 in., 3½ in. on each side of the beam. The usual criterions regarding the total width of T, depth of slab, width of beam and length of span should, of course, be applied in order to see that the T design falls within their requirements.

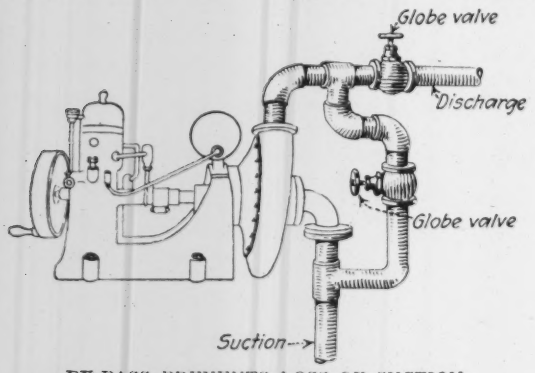
F. H. BURNETTE.

Indianapolis, Ind.

HINTS FOR THE CONTRACTOR

By-Pass Pipe Maintains Suction in a Centrifugal Pump

A SUCCESSFUL arrangement for preserving continuous flow and of preventing a centrifugal pump from losing suction due to low water in the sump, is shown by the accompanying sketch. The discharge is simply by-passed around the pump and through it again in such volume as the circumstances require. By proper adjustment of the globe valves on the discharge pipe and on the by-pass the water can be kept at any desired level in the sump. This arrangement is called to the



BY-PASS PREVENTS LOSS OF SUCTION

attention of contractors by R. T. Brown, chief of surveys, South Carolina State Highway Department. A method of accomplishing the same object by letting a controlled portion of the discharged water flow back into the sump through a trough, was described in *Engineering News-Record*, Jan. 8, 1920, p. 104.

Fast Work on Kerckhoff Tunnel

By R. K. Oberteuffer
Assistant Engineer, San Joaquin Light & Power Corporation, Auberry, Cal.

IN *Engineering News-Record* of Feb. 12, 1920, there was described the Kerckhoff power project of the San Joaquin Light and Power Corp., more especially the 18,000-ft. tunnel. Since that article there have been several changes in methods and contractors. D. D. De Luca, the contractor who started the south portal, is now also driving the north portal and Adit 1. W. A. Whitmire, former general superintendent, holds the contract for Adit 2, driving north and south from that point. Some remarkably fast tunneling has been done on this enterprise during recent months, especially in Adit 1.

The contract for Adit 1 was formerly held by Contractor Iverson, whose best record, made in November, 1919, was 399 ft. Contractor De Luca took over this tunnel on Feb. 1, 1920, driving 344 ft. in that month. In March he made 439 ft., and in April 451 ft. The following facts in connection with the April performance may be of value for comparison with the details of other tunneling:

Heading and bench method used, with a 14- or 15-ft. bench. Holes in bench, 16; one shift of drillers loads and shoots all holes, working from 7:30 p.m. to 4:30 a.m. Holes in heading, 38 to 46; one shift of drillers works usually from 2 p.m. to 11 p.m. The first round is usually fired at midnight. Four men muck back after shooting and go home when finished, usually after 7 hr. work. Mucking is done by a Marion 40 steam shovel, loading into a three-car train, cars holding 6 cu.yd. The shovel works from 10 a.m. to 5 p.m.

There was 30,657 lb. of 60 per cent powder used during April, or an average of about 68 lb. per foot. A total of 5,640 cu.yd. of material was taken out. George De Luca and John Bracca are shift bosses for the contractors.

Prizes for Shaft-Sinking Record

THE *Engineering and Mining Journal*, in its issue of May 15, offers a gold medal to the shaft-sinking crew breaking the present world's record of 310 ft. in 31 days, made by the Crown Mines, Ltd., Johannesburg, South Africa, during July, 1919. A silver medal will also be presented to each qualified member of the sinking crew.

The recent records are as follows:

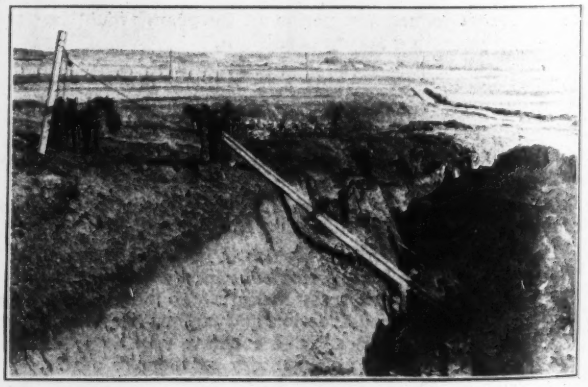
Distance	*Period*	*Date*	*Company*	*Place*
261 ft.	31 days	Aug., 1916	Walter Fitch, Jr.	Eureka, Utah
279 ft.	31 days	Dec., 1918	Crown Mines, Ltd.	Johannesburg, S. A.
310 ft.	31 days	July, 1919	Crown Mines, Ltd.	Johannesburg, S. A.
308 ft.*	31 days	Feb., 1920	Van Dyke Copper Co.	Miami, Ariz.

* Record in the United States.

Records will be judged by a committee of three, one member to be designated by the editor of the *Engineering and Mining Journal*, one by the director of the Bureau of Mines, and one by the secretary of the American Mining Congress. Rules governing the award will be formulated and published at a later date.

Inclined Skids Expedite Excavation of Deep Trench

INCLINED poles formed a skid, up which excavated material from a deep unbraced trench for a water main near Denver, Colo., was hauled in a slip scraper. Most of the excavation was carried out by teams and scrapers in the ordinary way except for turning the bottom. The material was hauled longitudinally in the trench to the foot of the skids by wheelbarrows which were dumped into the scraper. At the top, the material was taken back from the trench edge by a scraper. The work was carried out for the Denver Union Water Co., under the direction of D. G. Thomas, Chief Engineer.



NEWS OF THE WEEK

New York, June 10, 1920

Water-Power Bill Fails To Become Law

President Neglects To Take Action Before Congress Adjourns—No Explanation Given

(Washington Correspondence)

By what is colloquially known as a "pocket veto" the Federal Water-Power Bill, passed by both houses of Congress on May 29 automatically failed to become a law when Congress adjourned on June 5, before the President took any action on it. By the constitution if the President does not take action on any bill within ten days the bill automatically becomes law, except if congress adjourns before the ten day period expires when the bill fails of enactment.

Explanations that do not explain are the order in Washington with respect to the failure of the bill. The nearest to an official statement in the matter was made informally by Secretary Tumulty, who announced that Secretary John Barton Payne, of the Interior Department, was vigorously opposed to the measure and then later stated that the President had received this and other bills at too late a date to permit his final consideration and favorable action in view of a serious difference of opinion which has developed.

The Water-Power Bill went to the President for signature about June 1. On June 3 it was referred to the Secretaries of War, Interior and Agriculture, who by the terms of the bill, would have been members of the proposed Federal Power Commission. All three Secretaries reported to the President on or before Saturday, June 5. It is known that the Secretaries of Agriculture and War reported favorably, recommending that the bill be signed. However, Mr. Tumulty's statement above referred to, clearly implies that the Secretary of the Interior recommended against the bill. This fact is also borne out by the general belief that Secretary Payne is personally opposed to the measure. The nominal grounds upon which he is supposed to have recommended veto are that such an Act would tend to destroy the national parks. Considerable credence may be given to the story on the ground that Judge Payne has been, since 1911, President of the Board of South Park Commissioners of Chicago, and this activity is known to have received the greatest personal interest and attention of the President.

There is no question but that the bill is still objected to by several influences, for as late as the time of the confer-

(Continued on p. 1176)

American Society Takes Issue with Council In Pittsburgh Bridge Case

Action of Engineering Council Unauthorized, Says Board of Direction—Statement of Principle Reaffirmed

Reaffirming its previous statement of principle that only civil engineers should be entrusted with responsibility for bridge design and construction, the Board of Direction of the American Society of Civil Engineers on June 2, 1920, adopted resolutions declaring Engineering Council to have no authority to deal with the matter, as being one solely within the province of civil engineers. A joint committee of Council and the American Institute of Architects which considered the question of architects and engineers in bridge design reported its findings recently, as summarized in an official statement from the council headquarters printed in these columns May 27, 1920, p. 1079. However, the official statement omitted the concluding sentence of the committee's report as quoted in the Board of Direction's resolution.

Resolution of Am. Soc. C. E. Board

"*Whereas*, The Board of Direction of the American Society of Civil Engineers on April 20th, 1920, passed the following resolution:

Whereas, It has come to the attention of the Board of Direction of the American Society of Civil Engineers that the work of preparing plans and specifications for and in supervising the construction of bridges and other important engineering structures has been awarded to architects, and

Whereas, The work involved in the design of such structures is primarily engineering with respect to safety, cost, design, and adequacy, and

Whereas, The procedure thus established is detrimental to the public interest, in that it subordinates the safety, adequacy, and cost of such structures to their appearance, therefore be it

Resolved, That it is the opinion of the Board of Direction of the American Society of Civil Engineers that the responsibility for the design and construction of such work should be entrusted only to qualified civil engineers.

Following which copies were sent to Engineering Council and to the American Institute of Consulting Engineers for their information, and

"*Whereas*, A joint committee of Engineering Council and the American Institute of Architects at a meeting held May 4, 1920, in Washington, D. C., adopted the following:

The safety, adequacy, durability and suitability of purpose in any structure, whether bridge or building, are axiomatic. Under certain conditions structures should in addition be aesthetically excellent. In such cases the design must involve, therefore, collaboration between engineers and architects. Whether the engineer is chief and the architect associate or vice versa is an administrative detail of relative unimportance. Either combination should secure satisfactory results. The Committee cannot, therefore, concur in principle with the resolution of the American Institute of Consulting Engineers of Feb. 5, 1920, or in the resolution of the American Society of Civil Engineers of April 20, 1920.

"*Be It Resolved*, That the Board of

Senate Committee To Study Construction Shortage

A committee of the United States Senate has been appointed by the Vice-President pursuant to Senate Resolution 350 to look into and report on the present construction situation. The specific things to be looked into according to the words of the resolution are: "(a) The existing situation in relation to the general construction of houses, manufacturing establishments and buildings, and the effect thereof upon other industries and upon the public welfare, and (b) such measures as it may deem necessary to stimulate and encourage such construction work, to encourage popular investment rather than spending, to foster private initiative in building, and to insure cooperation between labor and persons or corporations engaged in transportation, banking, or other business necessary to the development of such construction."

The committee consists of W. M. Calder, chairman; W. S. Kenyon, W. E. Edge, E. J. Gay and J. O. Wolcott. The chairman may be addressed Special Committee on Reconstruction and Production, Senate Office Building, Washington, D. C. He is anxious to get the names of any persons who may have information regarding housing and industrial shortage or who has any suggestions regarding the present construction situation.

Utah County Reconsiders Bonds

Because of the high cost of construction material and the condition of the bond market the County Commissioners of Cache County, Utah, have decided that the county shall not now be bonded for $700,000 to supply money for road construction. The cost of the bond election was also considered objectionable.

Direction of the American Society of Civil Engineers reaffirms its attitude as previously indicated by its resolution of April 20, 1920, and expresses its view that the matter of bridge design as established by practice is one solely within the province of civil engineers, and it is therefore not a matter upon which Engineering Council has been delegated authority of action.

"*Resolved Further*, That Engineering Council be requested to refrain from any attempt to represent this society in discussion of this matter.

"*And Whereas*, Publicity has been given to action of the joint committee of Engineering Council and the American Institute of Architects as above cited, the Secretary is instructed to send copies of this resolution to Engineering Council, American Institute of Architects, and to the technical press."

Population of New York City Was 5,621,151 Early in January

The population of New York City, according to the count made by the Bureau of the Census early in January, was 5,621,151, but the figures are subject to final revision. The figures by boroughs and for the entire city, compared with like figures for 1910 and 1900, with increases by totals and percentages, are as shown in the accompanying table.

POPULATION OF NEW YORK CITY IN 1920, 1910 AND 1900

	Population			Increase 1910-20		Increase 1900-10	
	1920	1910	1900	Number	Per Cent	Number	Per Cent
Manhattan	2,284,103	2,331,542	1,850,093	*47,439	*2.0	481,449	26.0
Bronx	732,016	430,980	200,507	301,036	69.8	230,473	114.9
Brooklyn	2,022,262	1,634,351	1,166,582	387,911	23.7	467,769	40.1
Queens	466,811	284,041	152,999	182,770	64.3	131,042	85.6
Richmond	115,959	85,969	67,021	29,990	34.9	18,948	28.3
New York City	5,621,151	4,766,883	3,437,202	854,268	17.9	1,329,681	38.7

* Decrease.

Engineering Foundation Seeks Endowments

Engineering Foundation is in possession of a fund of somewhat above $300,000, practically all of which has been given by Ambrose Swasey. With the proceeds of this endowment it has maintained a liaison between engineers as represented by the founder and other societies and scientific workers as represented in the National Research Council. It is felt, however, by the Foundation that its field is very much greater and that it could do a much more useful work if it were in possession of greater funds. It is, therefore, making known that it is in a receptive mood toward contributions which would bring the endowment fund up to at least a million dollars in the near future. The Foundation does not plan to build laboratories and conduct research work directly, but rather to stimulate, co-ordinate, and support research work in existing scientific and industrial laboratories, co-operating in so far as may prove advantageous with the National Research Council. Charles F. Rand has been elected chairman of the Foundation to succeed Dr. W. F. M. Goss, resigned. The office is in the Engineering Societies' Building, 29 West 39th St., New York City.

Work on Safety Codes Initiated By Standards Committee

Arrangements have been made for the formulation of a considerable number of safety codes under the auspices of the American Engineering Standards Committee. The subjects of the codes for which arrangements have been completed, together with the organizations designated as sponsors, are: *Abrasive Wheels* — Grinding Wheel Manufacturers of the United States and Canada, and International Association of Industrial Accident Boards and Commissions. *Explosives* — Institute of Makers of Explosives. *Foundries*—American Foundrymen's Association, and National Founders' Association. *Gas Safety Code*—Bureau of Standards, and American Gas Association. *Head and Eye Protection*—Bureau of Standards. *Paper and Pulp Mills*—National Safety Council. *Power Presses*—National Safety Council. *Pressure Vessels, Non-fired*—American Society of Mechanical Engineers. *Refrigeration, Mechanical*—American Society of Refrigerating Engineers. *Woodworking Machinery*—International Association of Industrial Accident Boards and Commissions, and National Workmen's Compensation Service Bureau.

A number of additional codes are under consideration. A large representative advisory committee of specialists, organized by the National Safety Council, the National Workmen's Compensation Service Bureau, and the Bureau of Standards, at the request of the committee, to act as its advisor, is actively working on the question of what additional codes are most urgently required and what organizations are in the best position to undertake sponsorship for such codes.

Work On Specifications

Five standard specifications were recently submitted by the American Society for Testing Materials for approval as "American Standards" of the American Engineering Standards Committee. The subjects are: Specifications for Drain Pipes, Test for Toughness of Rock, Test for Penetration of Bituminous Materials, Method for Distillation of Bituminous Materials Suitable for Road Treatment, and Method for Sampling Coal. They were referred to a special sub-committee to make recommendations for final action.

At the request of the Swiss Standards Association, Baden, Switzerland, for co-operation in the work of standardization of ball bearings, the committee has requested the American Society of Mechanical Engineers and the Society of Automotive Engineers to act as joint sponsors for the project.

Water Power Bill

(*Concluded from p. 1175*)

ence report to the Senate, barely a week before passage, Senators Lenroot, King and Norris all took occasion to point out their objection to the proposed regulation. Two grounds for opposition were thus cited: First, that the proposal made the development of water-power a dominating influence, even with the right on the part of the Federal Commission to interfere with navigation on important navigable streams; second, that the terms for continuing a license after the initial period were such as to give practically perpetual lease to the original licensee.

It is probably the opposition thus voiced has led to the common rumor in Washington, which however can not be confirmed, that either Senator Lenroot or Senator King had some influence in causing the "pocket-veto." In any event, great surprise is expressed at every turn that the President should have declined to sign a bill so well known as of great importance, solely on the ground that possibly some measure of damage might be done to our national parks.

Two power projects had been suggested as the possible cause of Secretary Payne's objection. It had been proposed that a dam be placed near the Idaho state line just outside of the boundaries of Yellowstone Park in such a way that the storage of water would have been within the park territory. Another dam on the Yellowtsone River, within the boundaries of the park, had also been proposed. It is quite possible that these two projects, among others, may have been the cause of the Secretary's feeling of opposition. However, he refuses to make any statement in the matter to the press, up to the time that this is written (June 9).

The provisions of the bill include arrangements that while license may be granted for dams, reservoirs and other projects in or upon any part of the public lands and reservations of the United States, these reservations are defined specifically to include national monuments, national parks, national forests, etc. It is evident therefore, that one who desired to object on this ground would find some measure of plausibility in the terms of the proposed act.

In view of the fact that objection came from the Interior Department it was questioned whether the United States Geological Survey might not also have opposed the legislation but Dr. George Otis Smith, director of the Survey, stated, "It was as much a surprise to me as to any one else that the bill was not signed."

Form New Firm of Engineering and Industrial Consultants

From the group of engineers who were associated in the War Department Claims Board, which adjusted all uncompleted contracts after the armistice, has been formed an organization named the Technical Advisory Corporation with offices at 132 Nassau St., New York City, for the purpose of carrying on an advisory engineering and general consultant service. These men were connected with the Technical Advisory Committee of the War Department which reviewed practically all claims and proposed settlements presented for adjustment, made physical investigations and appraisals, scrutinized costs and policies, investigated management, methods, material economies and disposals, prices and rates, conducted negotiations and public hearings, and recommended final action. The work which they now propose to carry on is of somewhat similar nature. The company will not undertake contracts for construction or assume financial responsibility, but will offer two classes of service—industrial and engineering. In the former it undertakes work as economists, cost reducers and business advisers; in the latter it will furnish complete factory and institutional layouts and specifications and supervise the execution of plans. It also will offer a routine retainer service to merchants and manufacturers.

The officers are Campbell Scott, president, and Ernest P. Goodrich, William D. Ennis, and Rumsey W. Scott, vice-presidents. C. Scott, who was chairman of the Technical Advisory Committee of the War Department, has been a manufacturer and administrator with the General Electric Co., C. & C. Electric Co., Southern Engineering Co., Otis Elevator Co., Crocker-Wheeler Co., etc. Mr. Goodrich, following a term of service as civil engineer, United States Navy, has been in extensive civil engineering practice for a number of years. Mr. Ennis is a specialist on fuel, power and economics of material utilization and has been connected with the American Locomotive Co., the American Linseed Co., and the Watervliet Arsenal. Rumsey Scott has been sales engineer and district manager for corporations manufacturing elevators and electrical equipment, and is a specialist on the economics of material transport, and on passenger and freight elevator installation. Associated with the main officers are Frank B. Malty who has been a civil engineer on many railroads, river and canal works, and who was, as lieutenant colonel of engineers, in charge of construction of railways, docks, terminals and warehouses at St. Nazaire, France; Walter Rautenstrauch, advisory engineer to manufacturers and mechanical engineer; George B. Frankforter, chemist and metallurgical engineer; Arthur W. Hixson, chemical and metallurgical engineer, and Fred E. Rogers, mechanical engineer and editor of *Machinery*.

Minnesota Engineers and Architects Plan United Action

A definite move is under way in Minnesota to combine the public activities of all the engineers and architects in the state. It is proposed to form a state organization embracing the local organizations of St. Paul, Minneapolis, Duluth and the Iron Range, the state society and the members of the national societies not affiliated with local organizations. About four years ago, the Minnesota Joint Engineering Board was formed, consisting of representatives from the nine engineering organizations in the State. The new plan is to unite the individual members along the same line, and in addition, include the architects.

For the purpose of discussing such a plan, a meeting has been called for June 19-20, in Duluth, to which all engineers, architects and their friends are invited. Ladies are urged and expected to attend. A special train will leave the Twin Cities, Friday evening, June 18, and return Sunday evening, June 20. There will be inspection trips Saturday morning, a business session in the afternoon and an informal dinner dance in the evening. Sunday will be devoted to visits to various points of interest.

Cement Association Protests Road Construction Limitation

Acting upon the report that the Association of Railway Executives intended to urge upon the Interstate Commerce Commission the necessity of refusing cars for road building materials, the Portland Cement Association has issued a circular letter registering its emphatic protest against any further obstacles to highway construction. The letter further points out that for the past two or three years highway programs have been either suspended or seriously curtailed. In view of impending food shortages and also because of the relief highway transportation offers to the railroad industry, "such discrimination as that proposed should not now be tolerated," the letter states. The Portland Cement Association believes that greater need of highway transportation will be felt when crops are moved later in the season and that nothing should be put in the way of offering relief by the continuance of essential roadwork.

Pennsylvania Road Program

According to recent reports from the Pennsylvania State Highway Department, there are under construction approximately 950 miles of highway in that state at the present time. It is expected that contracts will be let on fifty more miles during the current month, bringing the total to 1,000 miles of new highway being constructed by the state. So many detours are made necessary through this construction that the highway department issues periodic bulletins for the convenience of motorists indicating where the detours are.

Advisory Council to Map Board Is Named

Organizations interested in map-making have designated representatives who will act as an advisory council to the United States Board of Surveys and Maps. Included in the list are the following:

American Society of Civil Engineers Prof. J. K. Finch, Columbia University, New York City; American Association of State Highway Officials, M. W. Watson, state highway engineer, Topeka, Kansas; American Geographical Society, Dr. Isaiah Bowman, director, New York City; American Railway Engineering Association, J. H. Milburn, office engineer Baltimore & Ohio Railroad, Baltimore, Md.; American Society of Mechanical Engineers, J. Waldo Smith, chief engineer, Board of Water Supply, New York City; American Water Works Association, Robert E. Horton, Voorheesville, N. Y.; Engineering Council, A. Stuart Baldwin, vice-president, Illinois Central Railroad, Chicago, Ill.

Federal Department of A. A. E. Formed at Washington

Government engineer members of the American Association of Engineers held a convention at the Washington Hotel, Washington, D. C., May 22, and formed a Federal Department of the A. A. E. A constitution and by-laws were adopted providing for a council of eight men who are to devise ways and means of obtaining the objects of the Federal Department. Four men were elected for 2 years and four for one year.

The object of the Federal Department shall be to improve the economic conditions in the government service by increasing efficiency and by any just means found advantageous to the welfare of the federal service and to the federal employees.

Among the matters discussed at the convention were means of saving the engineering service of the various government departments from what threatens to be a total collapse because of depletion of personnel. Statistics were cited to show that last year the number of technical engineers in the War Department alone had been reduced by voluntary resignations from approximately 1,000 to 525. An investigation into the causes of such wholesale resignations revealed, it was stated, that the men resigned to accept positions which pay on an average 64 per cent more than they received from the government.

At the evening session, held in the offices of the Board of Trade, the convention was addressed by M. O. Leighton, chairman of the National Public Works Department Association. He called attention to the fact that the per capita cost of running the government in 1914 was about 17c.; it is now $47. He pointed out that there are 29 agencies of the government doing public construction work and estimated that 20

per cent of the amount spent on public construction could be saved by placing all of this work under a single head.

Addresses were also made by F. E. N. Thatcher, district eastern secretary of the Ohio Valley District, and L. B. Smith, northeastern district secretary, describing the work of the American Association of Engineers in their districts.

Toll Bridge To Be Acquired By Condemnation

In negotiations for state purchase of the toll highway bridge over the Delaware River between Phillipsburg, N. J., and Easton, Pa., it has not been possible to agree on a price. The joint interstate commission valued the bridge at $225,000, but the owners demand $400,000, it is said, the latter figure representing double the highest recorded price at which stock has been sold. The commission now plans to institute condemnation proceedings.

Proposed Bill Would Use Allied Debt for Road Building

A bill has been introduced into the House of Representatives providing that the allied war debt to the United States be set apart as a fund to be held in perpetuity by the Government, and the interest and income arising therefrom to be used in the construction, maintenance and improvement of post roads and public highways throughout the United States. The war debt of Great Britain, France, Italy, Servia and Roumania to the United States aggregates $9,000,000,000 and the earnings from that fund the proposed bill would use subject to regulation prescribed by the Secretary of Agriculture, and also to conditions named in the Act of Congress approved in February, 1914, providing for the construction and maintenance of rural post roads. However, the proposed bill imposes the following conditions: (1) That the funds be distributed among the states, territories, and District of Columbia according to area, population, and miles of public highways and post roads improved and to be improved; (2) That when a certain amount of the allied indebtedness is paid back to the United States the Secretary of the Treasury shall direct the investment of the funds so provided.

Iowa State College Celebrates Semi-Centennial

Popular phases of engineering were covered in addresses by three prominent engineers at the engineering symposium held at Ames, Ia., on June 8 in connection with the semi-centennial celebration of Iowa State College. A. P. Davis, president of the American Society of Civil Engineers and director of the U. S. Reclamation Service spoke on the subject of present tendencies in engineering organizations. T. H. MacDonald, chief of the U. S. Bureau of Public Roads, a civil engineering graduate of the college, discussed "The Past, Present and Future of Highway Engineering and the Relation of Iowa State College Thereto." J. W. Hook, president of the Allied Machinery Corporation, talked on "The New Business World and the New Business Training for Engineers."

New Association for Universal Lumber Grading Rules

An intensive campaign for the adoption of uniformity in grading lumber and in the stock sizes as a means of bringing about more efficient distribution is the aim of the newly organized American Wholesale Lumber Association. Any movement for standardization comes from the consumers and L. R. Putnam, directing manager, states that the American Railway Engineering Association, the Western Society of Engineers and the American Institute of Architects have already made urgent requests for standardization. The new organization of wholesalers is working in co-operation with the National Lumber Manufacturers' Association. Committees will soon be named.

Kansas City Sanitary Committee

As a result of the success of its committee on traffic problems the Kansas City Engineers Club has appointed a Civic Sanitation Committee, the first problem for which will be the water supply system. The chairman is F. W. Fratt, manager of the Eclipse Valve Co.

Semi-Trailers Liable to Tax

Thousands of dollars in taxes are involved in a dispute between the Bureau of Internal Revenue and the Trailer Manufacturers' Association over the correct definition of a semi-trailer. The revenue law imposes a sales tax on automobiles, motor trucks, parts and accessories but does not mention trailers, and it specifically exempts tractors. Early in 1919 the Revenue Bureau ruled that tractors even when sold in combination with trailers were exempt and that trailers regardless of the number of wheels that they possessed were not parts or accessories of automobiles or trucks, which interpretation led trailer manufacturers to believe that all types of trailers were exempt from the sales tax. No returns were made and no taxes paid on sales.

In March of 1920 however, the bureau revised its ruling and held that tractors which support a part of a load, and semi-trailers for use of such tractors are both taxable, the former as an automobile truck and the latter as a part of a truck. By its most recent ruling the Bureau of Internal Revenue declared that taxes on sales of these articles must not only be paid hereafter but that the manufacturer must pay back taxes on sales from Feb. 25, 1919. It holds that the tax payer and not the bureau is responsible for any errors of interpretation of the law. What final disposition of the matter will be made has not yet been indicated.

Hold Hearing on Increased Niagara Power

Pursuant to a Congressional order Col. J. G. Warren, Corps of Engineers U. S. A., in charge of Great Lakes division of the U. S. Engineer Department, has made a report on the subject of water diversion from the Great Lakes to the Niagara River, including navigation, sanitary and power purposes, and the preservation of the scenic beauty of Niagara Falls and the rapids of the Niagara River. The report recommends a possible diversion of 120,000 sec.-ft. for power purposes at Niagara Falls, instead of the 50,885 sec.-ft. now permitted under treaty arrangement. This would be divided as 80,000 sec.-ft. above the Falls and 40,000 ft. below the Falls, and makes a large increase in the American utilization. It was also recommended that there be constructed above the point of the Horseshoe Falls a submerged weir of such dimensions that the water remaining in the river, estimated at 50,000 sec.-ft. as the extreme minimum limit, will be spread more evenly over the channel and the gorge. The weir, it is suggested, will serve to stop erosion which is now threatening to destroy the beauty of the Falls. Various suggestions are made as to the possible locations of developments to utilize the new power proposed.

A hearing was held on the report at Niagara Falls on June 3. Some objection was made by Buffalo interests that the report favored the Niagara Falls electrochemical industry too much, and opposition to the proposition of increasingly permitted utilization was made by J. H. MacFarland of the American Civic Association, on the ground that it would destroy the scenic beauty of the Falls. However, the hearing, which was before an army engineer board, was favorable to the Warren report.

Referendum Against Public Works Department

Although majority vote in favor of the Federal Department of Public Works was registered in the recent referendum of the Chamber of Commerce of the United States, that referendum failed to carry under the rule of the Chamber because there was not a requisite two-thirds majority. Out of the 1250 member organizations, 477 registered 1,375 votes. The three propositions submitted were: Shall the Department of Public Works be established by the National Government? In favor 826, against 549. Shall the Department of Public Works be established by a suitable modification of the existing Department of Interior excluding that from the non-related bureaus and officers by changing the name from the Department of Interior to the Department of Public Works. In favor 675, against 679. Shall the Department of Public Works be established by creation of an entirely new department? In favor 282, against 992.

Omaha Buys Gas Works

After thirteen years of effort the city of Omaha, Neb., has acquired the ownership of the gas works supplying the city. A bond issue of $3,500,000 for municipal ownership of gas works at Omaha was defeated at an election held in November, 1907. In May, 1918, the people voted to acquire the gas works at a price to be determined by a court. A valuation of $3,760,000 was placed on the plant by Burns & McDonnell, consulting engineers of Kansas City, representing the city. Valuations in behalf of the company were made as follows: H. C. Anderson, $5,518,000; William A. Baehr, $5,570,000; W. H. Taylor, $6,281,000. In February, 1920, the court awarded the gas company $4,500,000, and on March 20, 1920, the city commissioners voted to take over the works at the price stated and voted also $1,000,000 for improvements and extensions. The plant will be operated by the city under the direction of a bi-partisan board of directors and a manager.

Elected President of Institution of Civil Engineers

John A. Brodie, city engineer of Liverpool, England, has been elected president of the Institution of Civil Engineers. As an apprentice in civil engineering, he entered the shops of the Mersey Dock estate, in 1875, under the late G. Fosberry Lyster. In 1879, he secured a Whitworth Scholarship and spent three years in Sir Joseph Whitworth's works, at the end of which period he went to Spain in charge of harbor work there. After the completion of that work he was appointed general engineering assistant in the city engineer's office in Liverpool. He engaged in private practice with John T. Wood, in that city, in 1882, and designed and carried out an improved system of handling refuse at destructors. He also designed and developed a combined destructor and steam generator.

During his office as city engineer of Liverpool, Mr. Brodie has been in control of the operation and maintenance of over five hundred miles of road and nearly the same number of miles of sewers, as well as the cleansing operations of the city, requiring a staff of between three and four thousand men. He has also been in charge of the construction and maintenance of the permanent way and pavement of electric tramways, as well as the structures and electrical equipment for same. In connection with the road construction, Mr. Brodie has brought into extensive use in Liverpool concrete-macadam blocks and pitch-macadam pavements. He is also the originator of a concrete laborer's dwelling made from destructor clinker, which is now in use in Liverpool.

Mr. Brodie was one of the first members and a vice-president of the Liverpool Self-propelled Traffic Association, and has been frequently called upon to give evidence before committees and the Local Government Board regarding regulations in connection with heavy motor cars and street traffic. He is a member of the Institution of Mechanical Engineers and a past-president of the Liverpool Engineering Society. He has also had conferred upon him by the Liverpool University, of which he was elected a professor of engineering in 1903, the degree of Master of Engineering

He has been recently appointed adviser to the Government of India in the laying out of the new capital of Delhi, which engagement is expected to terminate in about five months.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN WATER WORKS ASSOCIATION, New York City; Montreal, June 21-26.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Asbury Park, N. J., June 22-25.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Sept. 13-17.

The Montreal Branch of the Engineering Institute of Canada has elected the following officers for the year 1920-1921: Chairman, Arthur Surveyer, vice-chairman, James H. Hunter, and secretary-treasurer, J. L. Busfield.

The Western Society of Engineers on May 28 made a trip to Madison, Wis., to inspect the machine-tool works of the Gisholt Machine Co., the newly completed State Capitol and its power plant, the Materials Testing Laboratory of the University of Wisconsin, and the Forest Products Laboratory. Special tests were conducted in the materials laboratory and the Forest Products Laboratory.

The Niagara Peninsula Branch of the Engineering Institute of Canada is making arrangements to hold a professional meeting at Niagara Falls, Ont., Sept. 16-18, 1920. The officers of the branch, elected for the following year, are: Chairman, W. P. Near; vice-chairman, N. R. Gibson; secretary and treasurer, R. P. Johnson.

The Louisiana Engineering Society held a regular meeting June 4 at which W. M. White, manager, hydraulic department, Allis-Chalmers Co., delivered an illustrated lecture.

The Oklahoma Society of Engineers held its mid-year meeting in Muskogee, June 8 and 9. A prominent place in the program was given to highway subjects. R. C. Terrell, state engneer of Oklahoma, spoke on "The Policies of the Highway Department." W. L. Benham, of Johnson & Benham, consulting engineers, Kansas City, Mo., delivered a paper on "Relative Cost of Municipal Improvements Before and After the World War." The evening session on the second day of the meeting was addressed by Governor Robertson of Oklahoma.

PERSONAL NOTES

JULIAN MONTGOMERY, formerly county engineer of Rockwell County, Tex., has been appointed city engineer of Wichita Falls, Tex.

HOMER HILLMAN has been appointed engineer of Sherman County Kan., with headquarters at Goodland.

L. C. TEETER has been appointed engineer of Riley County, Kan., with headquarters at Manhattan.

C. E. DONNELLY, chief draftsman, office of city engineer, Kansas City, Mo., has been appointed assistant city engineer.

ARTHUR R. HOLBROOK has been appointed office engineer in the special engineering bureau in charge of waterworks extension in Columbus, Ohio.

RICHARD A. MCFADDEN has resigned as surveyor of the Second Survey District of Philadelphia.

EUGENE PRENTICE, Pittsfield, Mass., has been appointed special assistant to the city engineer of Binghamton, N. Y.

CHARLES J. DES BAILLET, for the last three years manager and chief engineer of the Sherbrooke corporation, has been appointed by the Water Board of the City of Montreal, Canada, as engineer in charge of aqueduct work.

COL. SPENCER COSBY, Corps of Engineers, U. S. A., has been assigned to duty as division engineer at Savannah, Ga., succeeding Colonel T. H. Rees, who was recently appointed department engineer at San Francisco.

ARTHUR H. PRATT, designing engineer, North Jersey District Water Supply Commission, has been appointed deputy engineer.

ALBERT A. CHENOWETH and HERMAN RETTINGHOUSE have become associated in partnership under the firm name of Chenoweth & Rettinghouse, civil engineers, Boyce-Greely Building, Sioux Falls, S. D. Mr. Rettinghouse recently retired as chief engineer of the Chicago, Milwaukee, Minneapolis & Omaha Ry. Mr. Chenoweth has been engaged in private practice in Sioux Falls.

JEROME H. FERTIG, engineer for the Ralph Schneeloch Co., Portland, Ore., and chief engineer and member of the Board of Directors of the Mt. Shasta Land and Irrigation Co., has been appointed project engineer of the Grants Pass Irrigation District, Grants Pass, Ore.

E. C. HALL, previously of the Worden Allen Co., Milwaukee, has entered private practice, specializing in construction engineering, with offices in the Majestic Building, Milwaukee.

WALTER F. BARKER has been appointed New York district manager for the new office of the George F. Watts Corporation, engineers and contractors, at 30 Church St., New York City. Henry Porlier is chief engineer.

H. N. AIKMAN, who has been associated with the Dwight P. Robinson Co., New York City, has become engineer in charge of structural steel design, Fargo Engineering Co., Jackson, Mich.

CLARENCE H. LARSEN and JOHN GLENN MASON have become associated in partnership under the firm name of Larsen & Mason, architects and engineers, Terminal Building, Lincoln, Neb.

J. S. SHAW, who before the war was engaged in construction work in Texas at Fort Worth, Dallas and Austin under the name of the Shaw Construction Co., has been elected general manager of the Mackle Construction Corporation, Atlanta, Ga.

ERMON M. PECK, formerly resident engineer of housing developments at Cradock and Truxtun, Va., United States Housing Corporation, has been appointed general manager, Hartford Home Building Association, Inc., Hartford, Conn.

J. ROSS EAKIN, United States Geological Survey, sailed from Seattle May 20, in charge of a party which will make topographic surveys in the Mt. McKinley region of Alaska.

C. L. NELSON, United States Geological Survey, will be in charge of field parties, which will undertake the mapping of the Conejos quadrangle of Colorado.

A. O. BURKLAND, United States Geological Survey, has been appointed in charge of field surveys to be undertaken in Hawaii through a co-operative agreement with the Territory.

FRANK S. KNITTLE, formerly county and city engineer, Douglas, Wyo., has been appointed city engineer of Casper, Wyo.

W. S. RICHMOND, Larner-Johnson Valve and Engineering Co., Philadelphia, has become principal assistant engineer to Col. W. P. Wooten on the St. Lawrence River surveys.

JOSEPH A. MARTIN, commissioner of purchases and supplies, Detroit, has been appointed commissioner of public works for that city, succeeding George Engel, recently resigned.

LEWIS D. KELSEY, formerly city engineer of Aberdeen, Ore., has been appointed city engineer of Raymond, Ore.

CHARLES A. WILL, secretary, W. H. & F. W. Cane, Inc., and James W. Nelson, construction superintendent of the same firm, have retired from that organization and have become associated in partnership under the firm name of Will & Nelson. They will engage in general building and contracting, with offices at 307 Washington St., Brooklyn, N. Y.

J. WALTER ACKERMAN, chief engineer and superintendent, Board of Water Commissioners, Auburn, N. Y., has resigned to become superintendent of the water, light and power department of Watertown, N. Y.

OBITUARY

LOUIS J. PUTNAM, chief engineer, Chicago & Northwestern Ry., was drowned near Leroy, Mich., May 31, while attempting to rescue his son. He was born at Manchester, Iowa, in 1878, and was educated at Cornell College, Mount Vernon, Iowa. He began railroad work in June, 1898, with the Illinois Central, and a year later entered the engineering department of the Chicago & Northwestern as an instrument man. In February, 1901, he was appointed assistant engineer and thereafter was engaged on construction, location and maintenance work. He was later made acting division engineer of the Ashland division, with headquarters at Kaukauna, Wis. In March, 1907, he was assistant engineer in charge of second track and terminal improvements at Janesville, Wis., and later assistant engineer in charge of the construction of the bascule bridge over the north branch of the Chicago River and the Wells Street yard at Chicago; resident engineer, Milwaukee track elevation, and resident engineer, Escanaba Ore Dock construction. From July, 1910, to April, 1912, he was in the service of the Milwaukee, Sparta & Northwestern, a subsidiary of the Chicago & Northwestern Ry., first as resident engineer on construction, and then as acting resident engineer. In April, 1912, he was promoted to division engineer at Boone, Iowa, and in May, 1913, he became principal assistant engineer of the Northwestern, with headquarters at Chicago. In June, 1918, he was appointed chief engineer of the Northwestern.

WILLIAM MAXWELL BROWN, chief engineer, Passaic Valley Sewerage Commissioners, died at his home in Newark, N. J., May 29, at the age of sixty-six. Mr. Brown entered engineering work in 1874 as assistant engineer in the office of the city engineer of Providence, R. I., and was afterwards resident engineer on the extension of the water-works of Brookline, Mass. From 1878 to 1884 he was assistant on the construction of the Boston drainage works, and later was assistant engineer for the Massachusetts Drainage Commission and chief engineer of the water-works of Westerly, R. I. In 1895 he became superintendent and chief engineer, Metropolitan Sewerage Board, Boston. When the Metropolitan Water and Sewerage Boards were combined, he became chief engineer of sewerage works, which position he held until coming to Newark in 1912 as chief engineer of the Passaic commission.

EDMUND GYBBON SPILSBURY, mining and metallurgical engineer, died in New York City, May 28, at the age of seventy-five. He graduated from the University of Louvain, Belgium, in 1862, and came to the United States after engaging in mining and civil engineering work in Europe and Africa for eight years. He was a member of the American Society of Civil Engineers and was a trustee of the United Engineering Society from 1916 until his death, as well as a member of the Engineering Foundation Board. He was chairman of the Engineering Societies' Library Board from 1918 to 1920, and was a member of the board from 1913.

BUSINESS NOTES

THE PARSONS ENGINEERING & MACHINERY CORPORATION, New York City, has recently been organized to carry on the business of handling contractors' construction equipment. H. F. Parsons, formerly in charge of the construction equipment department of the P. W. Burnham Co., 111 Nassau St., and during the war superintendent for Thompson Starrett Co., is general manager of the new company. The construction department of the Burnham Co. has been abandoned and the business will be conducted by the Parsons Corporation.

THE WORTHINGTON PUMP & MACHINERY CORPORATION, New York City, announces that, in addition to its other lines of hydraulic machinery, it has now completed preparations to furnish improved water-power machinery of all capacities for low, medium and high head service, including oil pressure systems, water-wheel governors and other auxiliaries.

LOCKWOOD, GREENE & CO., engineers, New York City, have opened a Philadelphia office in charge of Charles P. Wood. At the outbreak of the war, Mr. Wood was chief engineer and superintendent of a ceramic plant at Metuchen, N. J. He entered the Army as lieutenant in 1917, and in 1919 acted in connection with a Government investigation of industrial machinery in France and Belgium, on which he was engaged until his association with Lockwood, Greene & Co.

W. T. CHOLLAR, previously of the Atlas Portland Cement Co., has been appointed district manager, Lakewood Engineering Co., with headquarters at the New York office, succeeding George S. Hedge, who has retired from active business. Mr. Chollar's experience in the construction field covers a period of nine years, beginning with his association with the Atlas company as Western sales manager. Since then he has served as manager of the service department of the Atlas company, comprising both the advertising and sales promotion departments.